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Volume XIII.

CATALOGUE

OF THE

METEORITES OF NORTH AMERICA,

TO JANUARY 1, 1909.

BY

OLIVER CUMMINGS FARRINGTON.

EXPLANATION OF ABBREVIATIONS USED ON MAPS.

The terms are those of the Rose-Tschermak-Brezina classification. The capital of each State is shown.

Cc	Stone, Spherulitic chondrite.
Cca	Stone, Veined spherulitic chondrite.
Ccb	Stone, Breccia-like spherulitic chondrite.
Cco	Stone, Ornans spherulitic chondrite.
Cck	Stone, Crystalline spherulitic chondrite.
Cg	Stone, Gray chondrite.
Cga	Stone, Veined gray chondrite.
Cgb	Stone, Breccia-like gray chondrite.
Chla	Stone, Veined chladnite.
Cho	Stone, Howarditic chondrite.
Ci	Stone, Intermediate chondrite.
Cia	Stone, Veined intermediate chondrite.
Cib	Stone, Breccia-like intermediate chondrite.
Ck	Stone, Crystalline chondrite.
Cka	Stone, Veined crystalline chondrite.
Ckb	Stone, Breccia-like crystalline chondrite.
Cs	Stone, Black chondrite.
Csa	Stone, Veined black chondrite.
Csb	Stone, Breccia-like black chondrite.
Cw	Stone, White chondrite.
Cwa	Stone, Veined white chondrite.
Cwb	Stone, Breccia-like white chondrite.
D	Iron, Ataxite.
Db	Iron, Babb's Mill ataxite.
Dc	Iron, Cape ataxite.
Dl	Iron, Linville ataxite.
Dn	Iron, Nedagolla ataxite.
Dr	Iron, Rafruti ataxite.
Ds	Iron, Siratik ataxite.
Dsh	Iron, Shingle Springs ataxite.
Dt	Iron, Tucson ataxite.
H	Iron, Hexahedrite.
Ha	Iron, Granular hexahedrite.
Hb	Iron, Breccia-like hexahedrite.
Ho	Stone, Howardite.
Kc	Stone, Carbonaceous, spherulitic chondrite.
M	Iron-stone, Mesosiderite.
Mg	Iron-stone, Grahamite.
O	Iron, Octahedrite.
Of	Iron, Fine octahedrite.
Off	Iron, Finest octahedrite.
Offbp	Iron, Breccia-like finest octahedrite.
Og	Iron, Coarse octahedrite.
Ogg	Iron, Coarsest octahedrite.
Oh	Iron, Hammond octahedrite.
Om	Iron, Medium octahedrite.
P	Iron-stone, Pallasite.
Pi	Iron-stone, Imilac pallasite.
Pk	Iron-stone, Krasnojarsk pallasite.
Pr	Iron-stone, Rokicky pallasite.

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CATALOGUE OF THE METEORITES OF NORTH AMERICA, TO JANUARY 1, 1909.

By Oliver Cummings Farrington.

INTRODUCTION.

Individual meteorite falls have an importance more or less comparable to that of individual species. The phenomena of fall, shape, size, chemical composition, and structure are largely peculiar to each fall and for purposes of exact knowledge should be fully recorded. The pursuit of the study of meteorites since they first began to attract attention has, however, been very irregular. The phenomena of fall and the more obvious features of shape and size have usually attracted sufficient attention to be described at the time, but the more intimate details of structure and composition, if described at all, have usually been recorded in stray, scattered studies often published without regard to the earlier history of the meteorite. Moreover, the advance of knowledge regarding meteorites has led to the observation of many features which were overlooked by earlier investigators. This is especially true with regard to structure, the intimate details of which have received great amplification under modern methods. On the other hand, classification has permitted grouping of features which were once described independently. Thus iron meteorites once regarded as peculiar on account of the lack of Widmannstätten figures are now readily grouped as hexahedrites or ataxites. Unless, however, we have a careful continuous record of the knowledge regarding each fall the details are liable to be hopelessly lost and the fall becomes more or less mythical in character.

Publications undertaking the preservation of such records have not been wanting hitherto. As early as 1803 Chladni prepared a chronological list of known meteorites [1] and issued supplementary lists up to 1826. The first general catalogue which was at the same time descriptive, however, was published by Buchner [2] in 1863. This catalogue gave a brief description of each fall, its bibliography, and a statement of the distribution of its specimens. The order of treatment was chronological, and there was a subgrouping into stone and iron meteorites, also of those seen to fall as distinguished from those found. Up to 1869 Buchner continued this work by means of appendixes, but at that time ceased his labors. Subsequent to this various lists of all meteorites were made, some of the most useful being those by Brezina, Meunier, Wadsworth, and Huntington, but none of them gave comprehensive accounts of all meteorites.

The largest comprehensive work following Buchner's was that of Wülfing, published in 1897.[3] This included all known meteorites, but the number of these had so largely increased since Buchner's time that his plan of giving an account of each meteorite was not followed. Wülfing confined his catalogue to a bibliography of each fall and a statement of the distribution of the specimens. Wülfing's work was performed with excellent judgment and thoroughness, and his catalogue has been of the greatest service in systematizing and advancing the study of meteorites.

Although the plan of giving an account of each meteorite, its bibliography and distribution, would seem impracticable when, as is now the case, the number of known meteorites exceeds 600, yet the task was undertaken by Cohen. Volumes III, IV, and V of his Meteoritenkunde were intended to be made up in this way. Of these, only Volume III was completed at the time of his death. This described in full 96 iron meteorites, comprising the classes of ataxites,

[1] Gilb. Ann. Bd. 15, p. 307–8. [2] Die Meteoriten in Sammlungen. Leipzig, 1863. [3] Die Meteoriten in Sammlungen. Tübingen, 1897.

hexahedrites, and fine octahedrites. Had Cohen lived to complete his task, little more could be asked for in the way of a systematic account of meteorites, but unfortunately this was not to be. Cohen's bibliography differed from Wülfing's in giving only the works which recorded new facts, whereas Wülfing listed every mention of the meteorite. In his statement of their distribution Cohen also mentioned only the most important. Both of these practices of Cohen seem to the present writer more nearly ideal than those of Wülfing. Neither of the catalogues mentioned undertook any mapping of falls.

In all these catalogues there is a confusing difference in the methods adopted for the grouping of those falls which have often been regarded as distinct. Thus Wülfing, to speak of American falls alone, grouped together Jewell Hill and Duel Hill, Lime Creek and Walker County, Coahuila, Sancha Estate and Fort Duncan, Brenham and Anderson, and Chupaderos, Adargas and Morito.

In earlier times the Red River meteorite of Texas and the Santa Rosa meteorite of the United States of Colombia were regarded by Shepard [1] as belonging to a single fall. Jackson [2] thought that the Port Orford, Oregon, meteorite should be considered of the same fall as the Pallas iron. More recently Huntington [3] placed together, as originating from one fall, Fort Duncan, Holland's Store, and Scottsville, although found hundreds of miles from each other; and Cocke County, Sevier County, Wayne County, Greenbrier County, Waldron's Ridge, and Tazewell, although scattered over three States. Preston [4] concluded that the meteorites of western Kansas—Kansada, Jerome, Long Island, and Prairie Dog Creek—came from a single shower.

It seems obvious that such practices would in time produce great confusion and that the chances of lessening such a confusion would decrease as time passed. The history and geography of a fall must be the important factors in determining its right to be regarded individual. Of these two factors the history must be determined from all available literature, while the geography can readily be shown by mapping. To undertake this task for the meteorites of a single large geographic province such as North America seemed to the writer desirable, not only for the intrinsic value of the record, but to throw light on the question of the extent to which individual falls may be naturally or artificially distributed. Funds for assistance having been generously provided through a grant from the J. Lawrence Smith Fund of the National Academy of Sciences, such a catalogue was undertaken and is here presented.

Prof. W. C. MacNaul, of Chicago, rendered valuable assistance in the bibliographic work and translating. In the preparation of the text of this catalogue the endeavor of the writer has been to collect all published facts of importance regarding the different falls. Several methods of grouping these facts were considered, but it was finally concluded that an essentially chronological treatment would be the most satisfactory. Such a grouping shows in historical order the growth of knowledge regarding each fall and enables one to appreciate the difficulties of the earlier investigators and the manner in which features overlooked or not understood by them were later made clear. For example, Cambria was early described as showing nodules composed of two kinds of iron sulphide, one decomposable and regarded as troilite, the other unattacked by acids and regarded as pyrrhotite. It remained for later investigation to show that the undecomposable constituent was schreibersite.

In this catalogue original articles are generally given in full. This plan was not adopted without thorough consideration, especially as the practice of previous compilers had been to present only abstracts. By such a method desirable data may be omitted, however, since abstracts are necessarily affected by the ability of the abstractor to choose that which is important. The ideal to be attained seems to the mind of the writer to be the preservation of all known data regarding the meteorites. This does not mean that data shall be repeated, and the writer has omitted from later reports observations already recorded by earlier investigators. This was deemed desirable, not only in order to reduce the bulk of the catalogue, but also to give due credit to the first observer, and while it may seem to some to involve too great ver-

[1] Amer. Journ. Sci., 1st ser., vol. 16, 1829, p. 219.
[2] Proc. Boston Soc. Nat. Hist., vol. 7, 1860, p. 161.
[3] Proc. Amer. Acad. Arts and Sci., vol. 24, 1889, pp. 30–35.
[4] Amer. Journ. Sci., 4th ser., vol. 9, 1900, p. 412.

bosity the writer is confident that in the long run it will be found the most satisfactory. The absence of repetition affords a proper perspective of the work already done on each fall and should result in a clear appreciation of the lines along which further study should be carried out; in fact, the writer hopes that this may be one of the chief values of the catalogue.

In the bibliography given with each fall, only works which have treated in some detail of the meteorite have been recorded. The apparent plan of Wülfing to record every mention of the meteorite, while having its uses, has not been deemed practicable or necessary for this catalogue. Undoubtedly, some of the references recorded by Wülfing and omitted by the writer would at times be useful, but on the whole they are more of a burden than an addition. Thus, mention of a meteorite in various catalogues seems hardly worth perpetuating, and the plan of Buchner and Wülfing of recording in detail the distribution of the different specimens of each meteorite among different collections has not been deemed by the present writer worthy of continuance. The distribution of meteoritic material has now become so extensive and its subsequent exchange so general that such a record can have little permanent value. Accordingly, the only record of the distribution of each fall given in the present catalogue is that of the larger or more important pieces or, if the fall has been widely distributed, a statement to that effect.

In determining what falls to admit to the catalogue it was decided to include only those known to be meteoric. All false or doubtful meteorites were thus set aside, together with occurrences like that of Oktibbeha, which, though usually regarded as meteoric, are so anomalous in composition that their meteoric origin is uncertain. The Abert iron is also omitted because of its lack of locality and the possibility of its belonging to Toluca.

The extent to which different falls have been studied is, as shown by the catalogue, very unequal. Thus, the meteorites of the great showers, such as Brenham, Canyon Diablo, Estherville, Forest City, Homestead, New Concord, Toluca, and Weston have, as a rule, been extensively studied. This may be due either to the striking character of the phenomena of the fall or to the large quantity of material available for distribution to investigators. Conversely, of those meteorites represented by only a small amount of material little investigation has been made, although in no case can the amount of material be said to be too small for adequate study. North American meteorites of which our knowledge is still quite unsatisfactory, are the following: Bethlehem, Cosina, Deal, Emmetsburg, La Charca, Ottawa, Oroville, Pricetown, Rushville, and San Pedro Springs. Several of the Mexican meteorites, in addition, are little more than names, their only record being that of preservation in one of the Mexican museums.

Of the following North American meteorites the major portion seems to be lost, at least its present whereabouts are unknown: Botetourt, Danville, Forsyth, Greenbrier County, Harrison County, Hopper, Kokomo, Little Piney, Nobleboro, Petersburg, Pittsburg, Ponca Creek, Port Orford, Shingle Springs, Warrenton, and Wooster. The preparation of the present catalogue has served the purpose of locating a number of masses, the disposition of which was not recorded in Wülfing's catalogue. These are as follows:

Name of meteorite.	*Where chiefly preserved.*
Auburn	Amherst.
Bald Eagle	Lewisburg.
Bear Creek	Amherst.
Bethlehem	Albany.
Costilla Peak	Ward Collection.
Dalton	Philadelphia.
Deep Springs	Raleigh.
Denton County	Austin.
Descubridora	City of Mexico.
Grand Rapids	Distributed.
Iron Creek	Toronto.
Ivanpah	San Francisco.
Kenton County	Chicago.

Name of meteorite.	*Where chiefly preserved.*
La Charca	Guanajuato.
La Grange	Amherst.
Losttown	Amherst.
Madoc	Ottawa.
Marshall County	Amherst.
Marion	Amherst.
Morristown	Ward Collection.
Nelson County	Vienna.
Putnam County	Amherst.
Rancho de la Pila	London.
Ruffs Mountain	Amherst.
Russel Gulch	New York.
Searsmont	Amherst.
Smithville	Distributed.
Staunton	Distributed.
Tazewell	Amherst.
Tonganoxie	Distributed.
Trenton	Distributed.
Tucson	Washington and San Francisco.
Union County	Amherst.
Wichita	Austin.
Zacatecas	City of Mexico.

The mapping of the exact location of each fall or find has often proved, as might be expected, difficult. In addition to a frequent lack of definite statement in the description of a meteorite as to where it was obtained, it is probable that full credence can not always be given to the statements of a finder who may wish to conceal the exact location of the specimens, either in the hope of obtaining more or to avoid all question as to their ownership. The artificial distribution of iron meteorites from their original point of fall for purposes of artisanship is also likely to occur. Decision in each case as to how far the reported point of fall may have been affected by such considerations must obviously depend on individual judgment. In almost no instance, however, among the many investigated and mapped by the writer has there been proof of deliberate misrepresentation as to the point of discovery.

The greatest hindrance to exact knowledge has arisen, apparently, from lack of careful inquiry as to its place of fall on the part of those to whom has been given the privilege of describing the meteorite. By earlier writers it was deemed sufficient to characterize the locality of the meteorite by the name of the State in which it was found. As this practice soon became obviously faulty, due to the finding of several meteorites in the same State, the next plan largely adopted was that of naming the meteorites from the counties in which they fell. This practice was soon, of course, also found open to the objection of covering too much territory and was superseded by the modern method of naming the meteorite from a place of importance nearest its place of fall, a practice the establishment of which is largely due to Brezina. This method seems to be all that can be desired, and it is hoped that no other will in the future be used. One very desirable end attained is that the name of the meteorite gives at once its locality. The choice of the name should, if possible, be that of a town of sufficient size to be locatable in a good atlas, but where this would place the name of the meteorite too far from its place of fall the name of a smaller place may be used.

Where meteorites are known only by the State or county in which they fell it has often been impossible to show their exact location on the accompanying maps. If the only designation of the locality of a meteorite has been that of a county, the writer has indicated the county seat as the locality, although this is obviously a purely arbitrary assumption. The class to which a meteorite belongs has been indicated on the maps by an abbreviation of the term in the German classification. This is a most concise and practicable way of determining at a glance the character of contiguous meteorites. If meteorites of the same type appear close together there appears to be strong presumption for inferring that they belong to a single fall, but such associations are rare. Where they do occur, as in the case of Madoc and Thurlow,

study of the individuals is necessary to determine whether or not they belong together. In all such cases here studied, except possibly that of Cleveland and Dalton, the individuals have shown characters so different that one would not be warranted in placing them together. The placing of type symbols upon the maps also affords an opportunity of determining whether related types have a tendency to fall in the same region, but a study of the maps betrays little evidence of such a grouping.

The total number of meteorites recognized by the writer in North America up to January 1, 1909, is 247, a number which will obviously increase with the occurrence of new falls and finds. Of the 247 recognized meteorites, 161 are iron meteorites, 10 are iron-stone, and 76 are stone—a notable excess of irons. Of the irons, 3 (Cabin Creek, Charlotte, and Mazapil) have been seen to fall, of the iron-stones, 1 (Estherville), and of the stones, 56. Only meteorites actually observed are here regarded as having been seen to fall. When a meteorite has been found it has customarily been referred to some meteor which some one remembers to have seen in the neighborhood at some previous time. This practice does not seem to the writer a sound one, since there are few meteorites to which such a time of fall could not be ascribed without a possibility of verifying the connection.

Considering the province of North America as a whole, the distribution of known meteorites is most abundant in the eastern United States and in Mexico. Few meteorites are known in British North America and the western United States. There can be little doubt that the apparent scarcity in the localities indicated is largely due to lack of observers, as the writer has elsewhere urged.[1] It is not safe, however, to ascribe too much to this cause, since areas equally populated show great discrepancies in the number of their meteorites. One of the best illustrations of this is the State of Illinois. This is an area of 56,000 square miles in which there are no known meteorites. The greatest massing of meteorites in the whole province of North America occurs in the region of the southern Appalachians, where the States of Kentucky, Virginia, Tennessee, North Carolina, Georgia, and Alabama adjoin. A circle with a radius of 300 miles drawn about Mt. Mitchell, North Carolina, as a center, will include nearly half of the known meteorites of North America. Twenty-five of these, or nearly half of the known falls of the continent, are observed falls, and it would seem possible at first thought that many of the meteorites in this area might have come from a single shower. This would reduce the number, but the writer has made a careful study of the history of each meteorite and its geographic relation to those of similar character without finding any support for such a view. Not only does the area contain a large number of observed falls, but the finds embrace a variety of types larger than any known to be produced by a single shower. Meteorites of a single type are, as a rule, much more widely scattered than those of any single observed shower. As regards population in the area, conditions are only moderately favorable, since the area is not very thickly settled. The climate of the region is moist, the average yearly rainfall being 50–60 inches, so that a relatively rapid disintegration of iron meteorites might be expected. Yet in spite of so many conditions unfavorable to their occurrence in large numbers, meteorites are superabundant in this area. This seems to leave little doubt that some force tends to bring about their concentration here. It is noteworthy that this region includes the highest summits of the Appalachians, and this suggests either the presence of an extra-gravitational force or that a purely obstructive effect has been exerted by the high peaks. Studies of the gravitational effects of mountain masses indicate no force seemingly sufficient to affect the fall of a meteorite, though some such force may exist. Magnetic influences may also be suggested. Next to the massing of meteorites about the southern Appalachians, the most striking grouping seems to be within the borders of Kansas. Within the area of this State, about 82,000 square miles, 15 meteorites occur. Of these, four are observed falls. Those of the western part of the State are all stones, and an effort has been made[2] to show that they may have been the result of a single shower, but the history and characters of the meteorites, to the writer's mind, negative this view. The soil of the western part of Kansas is especially favorable to the finding

[1] Pop. Sci. Mon., 1904, pp. 351–354.

[2] Preston, Amer. Journ. Sci., 4th ser., vol. 9, 1900, p. 412.

of meteorites, as it contains few terrestrial rocks, but this advantage is perhaps neutralized by the scantiness of the population. The climate is dry, thus tending to the preservation of meteorites. The region is not itself mountainous, but is elevated and within a few hundred miles of the mountain masses which culminate in Pike's Peak.

Another grouping of meteorites in the province of North America appears to be that of the large iron masses along the Cordilleras. Such is the distribution of the two Chupaderos masses, weighing 20,881 kgs.; Morito, 11,000 kgs.; Bacubirito, 27,000 kgs.; Port Orford, possibly 10,000 kgs.; and Willamette, 13,000 kgs. In addition several smaller iron masses and the showers of Toluca and Canyon Diablo are included in this zone. Here again, gravitational or obstructive influences are suggested.

The three greatest meteorite showers of North America have all occurred within the State of Iowa, two of them within 65 miles of each other, the third 130 miles distant from either. The localities were Estherville, Forest City, and Homestead. Other great showers must have occurred when the iron meteorites of Canyon Diablo and Toluca fell, but the fall was unobserved.

The boundaries of States can have no influence on the distribution of meteorites, as they include areas of very different extent, yet some interest and convenience attaches to a record of the falls in the United States by States. Arranged from the highest to the lowest they are as follows:

Name of State.	*Number of meteorites.*
North Carolina	20
Tennessee	16
Texas	15
Kansas	15
Kentucky	14
Alabama	11
Georgia	9
Missouri	9
Virginia	6
Indiana	6
Ohio	6
Nebraska	6
New Mexico	6
California	6
New York	5
South Carolina	5
Maine	4
Iowa	4
Wisconsin	4
Colorado	4
Maryland	3
Pennsylvania	3
Michigan	3
Arizona	3
West Virginia	2
Arkansas	2
Minnesota	2
North Dakota	2
South Dakota	2
Oregon	2
Connecticut	1
New Jersey	1
Wyoming	1
Utah	1
Montana	1
Idaho	1

It is evident that the distribution of the localities from which meteorites are known, or what may be in short known as the distribution of meteorites, will be affected by at least four

terrestrial factors: (1) density of population, (2) character of population, (3) climate, and (4) character of soil. Density of population will increase the number of meteorites known from a region, because the greater the population the greater the number of observers and the more numerous the chances both that the meteorite will be observed when it falls and that it will be found after it has fallen. As regards character of population, a high order of intelligence is favorable not only to the observation but to the preservation of meteorites. The writer has elsewhere called attention [1] to the fact that the distribution of meteorites on a map of the world is almost exactly that of the Caucasian race. This seems to prove quite conclusively that the distribution of meteorites is largely dependent on the degree of civilization attained in a region. That this factor is more important than density of population is shown by the fact that no meteorites are known from China in spite of its immense numbers of people. In the province of North America it is hardly likely that the different degrees of intelligence existing in different regions would exert any discernible influence on the number of meteorites known. As regard climate, aridity may be doubtless considered favorable and humidity unfavorable to the preservation of meteorites. In a humid climate the iron meteorites disintegrate much more rapidly than in an arid climate, and to a certain extent the same is true of stone meteorites.

As regards character of soil, it is obvious that soils free of rocks would be most favorable to the finding of meteorites. The existence of such soils in Kansas and Texas has led to the discovery in those regions of meteorites that would probably have been overlooked in stony localities. An iron meteorite is, of course, more likely to attract attention in any soil than a stony meteorite, but the latter is quite likely to be overlooked in stony soils. From the above it appears that the most favorable terrestrial conditions for the finding of meteorites are those of a dense, intelligent population living in an arid climate and upon a pebbleless soil. Such conditions are not likely to exist together, but now one and now another will predominate in any given region. To a certain degree the absence of one is likely to offset the presence of another, but where several of these conditions are lacking and a preponderance of meteorites occurs other reasons must be sought. The eastern States of the United States as compared with the western States possess a relatively dense population, but a moist climate and rocky soil. Canada has a scanty population, a moist climate, and rocky soil. Mexico has the advantage of an arid climate but the disadvantage of a scanty and an illiterate population, and a more or less rocky soil.

No evidence has been obtained in the preparation of the catalogue which proves to the writer that the individual meteorites of a single shower may be scattered over wide areas. No observed shower has ever been known to distribute individuals over an area greater than 16 miles in length. Only complete similarity between more widely separated meteorites should warrant belief in more extended showers, and such similarity has never been established. A considerable likeness exists, it is true, among the medium octahedrites of the southern Appalachians, but a careful study of the history and structure of each discloses differences too great to warrant their being classed together. Another group of North American meteorites showing strong similarity is that of Coahuila. These are hexahedrites and are reported from localities the most extreme of which are nearly 300 miles apart. As hexahedrites are relatively rare among meteorites, it hardly seems probable that several would fall within a hundred miles of each other, although this is by no means impossible. It is of course true that there may have been artificial distribution, but of this there seems to be no positive evidence. A considerable uncertainty, however, attaches to the statements of the localities where the specimens were found, and until the localities can be more definitely established, either by new finds or by reliable evidence regarding the old finds, the question as to whether they represent parts of a widely distributed shower must remain an open one.

Important meteorite collections are possessed, at the present time, by seven institutions in North America: The American Museum of Natural History, Amherst College, Field Museum of Natural History, Harvard University, Mexican National Museum, United States National Museum, and Yale University. Of these, the Yale University collection is probably the oldest.

[1] Pop. Sci. Mon., 1904, p. 352.

Professors Silliman and Kingsley, as early as 1807, collected specimens of the Weston meteorite for the college, and the Red River meteorite, at that time the largest meteorite known, was presented to it in 1835. The growth of the Yale collection since that time has been steady and the latest catalogue (1897) gives a total of 201 falls, having a weight of 1,374 kgs. Besides the Weston and the Red River meteorites, important North American specimens in this collection are those of Cape Girardeau, Castine, Estherville, Forest, Hammond, Jerome, and Salt Lake City.

The Amherst collection began with the deposit there in 1861 of Shepard's meteorites, numbering 151 falls, several of which, however, later proved to be pseudometeorites. The chief additions to the collection were made by Shepard and the latest manuscript catalogue gives 300 falls, having a weight of 660 kgs. Important North American specimens in this collection are those of Bear Creek, La Grange, Losttown, Marshall County, Putnam County, Richmond, Ruff's Mountain, Tazewell, and Union County.

The Harvard collection, according to Huntington, had its nucleus in a collection of about 50 falls made by Prof. J. P. Cooke, but obtained its chief importance through the purchase in 1883 of the collection of J. Lawrence Smith. In 1897, according to Wülfing, the collection numbered 244 falls and had a weight of 1,754 kgs. Important North American specimens are those of Butler, Charlotte, Coahuila, Cynthiana, Estherville, Frankfort, New Concord, Vernon County, and Warrenton.

The collection of the United States National Museum is the gradual result of gift, exchange, and purchase. It has maintained a steady growth by this means and in addition includes a series of chiefly small specimens deposited by Shepard. The latest catalogue of the collection (1902) gives a total of 348 falls, weight not stated. Important North American specimens are: Allegan, Arispe, Bishopville, Canyon Diablo, Casas Grandes, Felix, Gargantillo, Hendersonville, Lexington County, Mount Vernon, Persimmon Creek, Travis County, and Tucson.

The meteorite collection of the Field Museum of Natural History originated in the purchase, at the time of founding the museum in 1894, of collections made by Kunz and Ward. One hundred and eighty falls were then acquired, having a weight of 2,099 kgs. The collection has gradually been increased so that it now numbers 300 falls and has a weight of 2,310 kgs. The most important North American specimens are Brenham, Canyon Diablo, Farmington, Indian Valley, Kenton County, Leighton, Long Island, Modoc, Saline, Shelburne, and South Bend.

The American Museum of Natural History possessed no important meteorite collection until the purchase of the Bement collection in 1898. This contained over 400 falls, mostly in small specimens, but many of them rare, and included Ottawa, Plymouth, Pricetown, Rushville, and San Pedro Springs. Subsequent to the acquisition of the Bement collection the Museum acquired the great Cape York and Willamette meteorites and Selma. In addition the private collection of Ward is at present on deposit at this museum.

The meteorite collection of the Mexican National Museum and School of Mines is chiefly notable for containing a number of the great Mexican iron meteorites. These include Adargas, Chupaderos, Descubridora, Morito, and Zacatecas, together with several smaller stones and irons which have never been described.

Other institutions in North America which contain meteorite collections of some size are Adelbert College, reputed to possess 143 falls (Wülfing); the California State Mining Bureau, containing among others Chilcat, Oroville, and the Carleton mass of Tucson; the Public Museum of Milwaukee, containing several masses of Trenton and other meteorites; the University of Minnesota, containing 54 falls; the Academy of Sciences of Philadelphia, containing Cleveland and about 50 other falls; and the Academy of Sciences of St. Louis, containing Fort Pierre and about 40 other falls.

Private collections of meteorites have not been wanting in North America, but they have for the most part been acquired by institutions. The earliest collections were those of Troost, Shepard, and Smith. The disposal of the collections of the two latter collectors has already been stated; the collection of Troost was probably in part acquired by Smith and in part scat-

tered. Later, Bailey, Bement, Kunz, and Ward formed important collections, all of which were placed in institutions, with the exception of that of Bailey, whose last catalogue recorded 309 falls weighing about 50 kgs. The last collection formed by Ward was the largest private collection of meteorites ever made and excelled all others in number of falls. In 1904 this collection numbered 603 falls and had a weight of 2,495 kgs.

Several foreign institutions possess important specimens of North American meteorites, those chiefly rich in this material being the British Museum of Natural History, the Museum of Natural History of Paris, and the Vienna Natural History Museum. Important North American specimens in the British Museum are those of Cosby Creek, Greenbrier County, and Mesquital; in the Paris Museum that of Charcas; and in the Vienna Museum, those of Babb's Mill, Bridgewater, Cabin Creek, Castalia, Chulafinnee, De Cewsville, Eagle Station, Joe Wright, Kendall County, Lick Creek, Mazapil, Mincy, Mount Joy. Nelson County, Prairie Dog Creek, Silver Crown, and Summit.

Among the authors who have been especially active in the investigation and description of North America meteorites, probably the foremost place should be given to Prof. J. Lawrence Smith, the founder of the J. Lawrence Smith Fund of the National Academy of Sciences. Professor Smith's contributions to the subject of meteorites cover a period of about 30 years, from 1854 to 1883, and number about 40 titles descriptive of meteorites, chiefly American. This work of Professor Smith is characterized by his customary accuracy and insight and is of enduring value. Its chief importance lies in careful description and correct recognition of chemical and mineralogical characters many of which had been badly confused by other investigators. Thus, he was the first to establish the fact that the chief constituent of the Bishopville meteorite was enstatite, after other able investigators, such as Waltershausen, Rammelsberg, and Rose had failed properly to determine its composition. Smith's establishment of the fact that copper is a constant ingredient of iron meteorites was another important discovery.

Charles Upham Shepard was also an active investigator of North American meteorites, his investigations covering a period much longer even than those of J. Lawrence Smith. Shepard's first paper (on the Richmond meteorite) was published in 1829 and his last in 1885. The intervening years were rarely without a description by him of some American meteorite. In addition to his descriptive work, Shepard was very active as a collector, and the preservation of much valuable meteoritic material is due to him. The collection now possessed by Amherst College is chiefly the result of his labors. While Shepard was thus an important contributor, from the historical and material side, to the study of meteorites, some of his observations failed to be confirmed by later investigators. Several new species of minerals which he reported in meteorites and several classifications which he outlined have not been generally accepted.

Other early American investigators who described more than one fall were Jackson, who gave several excellent descriptions and analyses, Troost, and the elder and junior Silliman.

In later years those connected with the collections at Harvard, Yale, and the National Museum have been chiefly instrumental in advancing our knowledge of American meteorites. They have included at Harvard, Wadsworth and Huntington; at Yale, Brush, E. S. Dana, Penfield, Newton, and Wright; at Washington, Merrill, Eakins, Whitfield, and Tassin; and in New York, Hovey and Davidson. Other investigators who may be mentioned are Genth, N. H. Winchell, and Snow. Among private collectors who were also investigators, G. F. Kunz and H. A. Ward have been especially active, Kunz having collected and described many falls, and Ward having rescued from oblivion many little-known meteorites and given accurate information in regard to them. Other collectors who have furnished both excellent material and descriptions are Howell, Hidden, A. E. and W. M. Foote, Preston, H. L. Ward, and S. C. H. Bailey, while the collection of C. S. Bement contained several meteorites not otherwise preserved. On the astronomical side should be mentioned the important work of Newton, Kirkwood, and Bowditch.

In spite of the large number of meteorites of Mexican origin, and the fact that many of them have been known for centuries, little investigation has been made of North American meteorites by Mexican authorities. In fact, the catalogue of Castillo may be said to be the only

important paper of Mexican origin on meteorites, and this catalogue is very brief. This lack of local investigation of Mexican meteorites has compelled obtaining accounts of these meteorites chiefly from foreign travelers and their reports are often incomplete and conflicting. Accordingly, our knowledge of Mexican meteorites is far from satisfactory. From the Dominion of Canada few meteorites are known, but these have been quite satisfactorily described.

To foreign students North American meteorites have furnished material for valuable contributions to meteorite knowledge. Chladni's early studies were in part based on North American material and Partsch, Rose, Reichenbach, Haidinger, and Rammelsberg later classified and analyzed many of these bodies. Succeeding or in part contemporaneous with the above investigators were Daubrée and Meunier in France, and Maskelyne and Flight in England. Original investigations of single American falls by these authors were, however, not numerous, and the publications relating to American meteorites in foreign works previous to the Vienna catalogue were largely copies of descriptions made by American students.

In later years the foreign investigation of American meteorites has been carried on chiefly by Tschermak, Brezina, Cohen, and Berwerth, and to some extent by Weinschenk and others. The completeness of the collection at Vienna enabled Brezina in 1885 and 1895 to make much needed careful comparisons of different meteorites, to determine to what falls they belonged and to clear up much of the confusion resulting from a previous lack of such opportunity. Thus he was able to show the distinctness of Misteca and Yanhuitlan, although they had been assigned to one fall, and of Chupaderos, Morito, and Adargas, also generally grouped as one. In addition, Brezina gave careful descriptions of the structural characters of a large number of iron meteorites. A somewhat similar work, though under a different classification, was performed by Meunier. An admirable work was performed by Cohen in his extensive studies of a large number of iron meteorites, many of them North American in origin. These studies were historical, chemical, and structural, and thoroughly gave the characters of the meteorites investigated. Some of Cohen's results which directly affect the identity of American meteorites, were his distinction of Duel Hill and Jewell Hill and of Lime Creek and Walker County and his detection of the pseudometeoric character of Scriba and Long Creek.

List of meteorites by States or countries.

	County.	Classification.	Latitude north.	Longitude west.	Remarks.
ALABAMA:					
Auburn	Lee	H	32° 37′	85° 32′	Found 1867.
Chulafinnee	Cleburne	Om	33° 35′	85° 42′	Found 1873.
Danville	Morgan	Cga	34° 24′	87° 5′	Fell 1868, Nov. 27.
Desotoville	Choctaw	H	32° 13′	88° 10′	Found 1859.
Felix	Perry	Kc	32° 33′	87° 12′	Fell 1900, May 15.
Frankfort	Franklin	Ho	34° 30′	87° 52′	Fell 1868, Dec. 5.
Leighton	Colbert	Cgb	34° 43′	87° 33′	Fell 1907, Jan. 1.
Limestone Creek	Monroe	Dc	31° 34′	87° 30′	Found 1834.
Selma	Dallas	Cc	32° 25′	87° 1′	Found 1906.
Summit	Blount	Ha	34° 13′	86° 30′	Found 1890.
Walker County		H	33° 50′	87° 15′	Found 1832.
ARIZONA:					
Canyon Diablo	Coconino	Og	35° 10′	111° 7′	Found 1891.
Tucson	Pima	Dm	32° 12′	110° 55′	Found 1851.
Weaver	Maricopa	D	33° 58′	112° 35′	Found 1898.
ARKANSAS:					
Cabin Creek	Johnson	Om	35° 24′	93° 17′	Fell 1886, Mar. 27.
Joe Wright Mountain	Independence	Om	35° 43′	91° 27′	Found 1884.
CALIFORNIA:					
Canyon City	Trinity	Og	40° 35′	123° 5′	Found 1875.
Ivanpah	San Bernardino	Om	35° 30′	115° 28′	Found 1880.
Oroville	Butte	Om	39° 18′	122° 38′	Found 1893.
San Emigdio Range	San Bernardino (southern part of county).	Cc			Found 1887.
Shingle Springs	El Dorado	Dsh	38° 43′	120° 53′	Found 1869.
Surprise Springs	San Bernardino	Om	34° 12′	115° 54′	Found 1899.

List of meteorites by States or countries—Continued.

	County.	Classification.	Latitude north.	Longitude west.	Remarks.
COLORADO:					
Bear Creek	Jefferson	Of	39° 38′	105° 16′	Found 1866.
Franceville	El Paso	Om	38° 48′	104° 35′	Found 1890.
Russel Gulch	Gilpin	Of	39° 47′	105° 31′	Found 1863.
Ute Pass	Summit	Ogg	39° 48′	106° 10′	Found 1894.
CONNECTICUT:					
Weston	Fairfield	Ccb	41° 13′	73° 27′	Fell 1807, Dec. 14.
GEORGIA:					
Canton	Cherokee	Ogg	34° 12′	84° 30′	Found 1894.
Dalton	Whitfield	Om	34° 59′	84° 54′	Found 1877.
Forsyth	Monroe	Cwa	33° 3′	83° 56′	Fell 1829, May 8.
Holland's Store	Chattooga	Ha	34° 22′	85° 26′	Found 1887.
Locust Grove	Henry	Ds	33° 20′	84° 8′	Found 1857.
Losttown Creek	Cherokee	Om	34° 10′	84° 32′	Found 1868.
Lumpkin	Stewart	Cck	31° 54′	84° 57′	Fell 1869, Oct. 6.
Putnam County		Of	33° 16′	83° 25′	Found 1839.
Union County		Ogg	34° 53′	83° 58′	Found 1853.
IDAHO:					
Hayden Creek	Lemhi	Om	45° 0′	113° 45′	Found 1895.
INDIANA:					
Harrison County		Cho	38° 12′	86° 8′	Fell 1859, Mar. 28.
Kokomo	Howard	Dc	40° 34′	86° 2′	Found 1862.
Plymouth	Marshall	Om	41° 20′	86° 18′	Found 1893.
Rochester	Fulton	Cc	41° 5′	86° 13′	Fell 1876, Dec. 21.
Rushville	Rush	Cg	39° 22′	85° 3′	Found 1866.
South Bend	St. Joseph	Pi	41° 40′	86° 15′	Found 1893.
IOWA:					
Estherville	Emmet	M	43° 24′	94° 50′	Fell 1879, May 10.
Forest City	Winnebago	Ccb	43° 17′	93° 38′	Fell 1890, May 2.
Homestead	Iowa	Cgb	41° 39′	91° 32′	Fell 1875, Feb. 12.
Marion	Linn	Cwa	41° 57′	91° 34′	Fell 1847, Feb. 25.
KANSAS:					
Admire	Lyon	Pr	33° 0′	96° 5′	Found 1891.
Brenham	Kiowa	Pk	37° 38′	99° 13′	Found 1885.
Elm Creek	Lyon	Cco	38° 30′	96° 10′	Found 1906.
Farmington	Washington	Csa	39° 48′	97° 5′	Fell 1890, June 25.
Jerome	Gove	Cck	38° 47′	100° 14′	Found 1894.
Long Island	Phillips	Ck	39° 56′	99° 34′	Found 1891.
Modoc	Scott	Cwa	38° 29′	101°	Fell 1905, Sept. 2.
Ness County		Cib	38° 30′	99° 37′	Found 1897.
Oakley	Logan	Ck	38° 55′	101° 0′	Found 1895.
Ottawa	Franklin	Cho	38° 37′	95° 18′	Fell 1896, Apr. 9.
Prairie Dog Creek	Decatur	Cck	39° 42′	100° 24′	Found 1893.
Saline	Sheridan	Cck	39° 22′	100° 27′	Fell 1898, Nov. 15.
Scott	Scott	Stone	38° 29′	100° 54′	Found 1905.
Tonganoxie	Leavenworth	Om	39° 8′	95° 7′	Found 1886.
Waconda	Mitchell	Ccb	39° 20′	98° 10′	Found 1873.
KENTUCKY:					
Bath Furnace	Bath	Cia	38° 2′	83° 37′	Fell 1902, Nov. 15.
Casey County		Og	37° 20′	84° 55′	Found 1877.
Cynthiana	Harrison	Cg	38° 24′	84° 16′	Fell 1877, Jan. 23.
Eagle Station	Carroll	Pr	38° 37′	85° 0′	Found 1880.
Frankfort	Franklin	Om	38° 7′	84° 57′	Found 1866.
Kenton County		Om	38° 40′	84° 29′	Found 1889.
La Grange	Oldham	Of	38° 37′	85° 25′	Found 1860.
Marshall County		Om	36° 50′	88° 17′	Found 1860.
Mount Vernon	Christian	Pk	36° 50′	87° 28′	Found 1868.
Nelson County		Ogg	37° 40′	85° 27′	Found 1860.
Salt River	Bullitt	Off	37° 56′	85° 54′	Found 1850.
Scottsville	Allen	H	36° 45′	86° 10′	Found 1867.
Smithland	Livingston	Db	37° 18′	88° 17′	Found 1839.
Williamstown	Grant	Om	38° 38′	84° 30′	Found 1892.
MAINE:					
Andover	Oxford	Cc	44° 36′	70° 47′	Fell 1898, Aug. 5.
Castine	Hancock	Cwa	44° 24′	68° 48′	Fell 1848, May 20.
Nobleborough	Lincoln	Ho	44° 4′	69° 28′	Fell 1823, Aug. 7.
Searsmont	Waldo	Cc	44° 22′	69° 12′	Fell 1871, May 21.

List of meteorites by States or countries—Continued.

	County.	Classification.	Latitude north.	Longitude west.	Remarks.
MARYLAND:					
Emmitsburg	Frederick	Om...	39° 43′	77° 20′	Found 1854.
Lonaconing	Allegheny	Og....	39° 28′	79° 2′	Found 1888.
Nanjemoy	Charles	Co....	38° 25′	77° 12′	Fell 1825, Feb. 10.
MICHIGAN:					
Allegan	Allegan	Cco...	42° 34′	85° 52′	Fell 1899, July 10.
Grand Rapids	Kent	Of.....	42° 59′	85° 42′	Found 1883.
Reed City	Osceola	Om...	43° 53′	85° 32′	Found 1895.
MINNESOTA:					
Arlington	Sibley	Om...	44° 30′	93° 56′	Found 1894.
Fisher	Polk	Cia....	47° 48′	96° 49′	Fell 1894, Apr. 9.
MISSOURI:					
Billings	Christian	Om...	37° 5′	93° 28′	Found 1903.
Butler	Bates	Off....	38° 18′	94° 25′	Found 1874.
Cape Girardeau	Cape Girardeau	Cc....	37° 13′	89° 32′	Fell 1846, Aug. 14.
Central Missouri	.....	Ogg...	[1]	[1]	Found 1855.
Little Piney	Pulaski	Cc....	37° 55′	92° 5′	Fell 1839, Feb. 13.
Mincy	Taney	M.....	36° 35′	93° 7′	Found 1856.
St. Francois County	.....	Og....	37° 55′	90° 36′	Found 1863.
St. Genevieve County	.....	Of....	37° 47′	90° 22′	Found 1888.
Warrenton	Warren	Cco...	38° 44′	91° 12′	Fell 1877, Jan. 3.
MONTANA:					
Illinois Gulch	Deer Lodge	Dn....	46° 39′	112° 32′	Found 1897.
NEBRASKA:					
Ainsworth	Brown	Om....	42° 33′	99° 48′	Found 1907.
Mariaville	Rock	Iron...	[2] 42° 45′	99° 25′	Des. 1897.
Lancaster County	.....	Iron...	40° 50′	96° 35′	Found 1903.
Ponca Creek	Holt	Ogg...	42° 45′	98° 55′	Des. 1863.
Redwillow County	.....	Iron...	40° 22′	100° 30′	Des. 1897.
York	York	Om...	40° 52′	97° 33′	Found 1878.
NEW JERSEY:					
Deal	Monmouth	Ci.....	40° 14′	74° 1′	Fell 1829, Aug. 14.
NEW MEXICO:					
Costilla	Taos	Om...	36° 50′	105° 13′	Found 1881.
El Capitan	Lincoln	Om...	33° 30′	105° 30′	Found 1893.
Glorieta Mountain	Santa Fe	Om...	35° 22′	105° 50′	Found 1884.
Luis Lopez	Socorro	Om...	34° 0′	107° 0′	Found 1896.
Oscuro Mountains	Socorro	Og....	33° 45′	107° 20′	Found 1895.
Sacramento Mountains	Otero	Om...	32° 32′	105° 20′	Found 1896.
NEW YORK:					
Bethlehem	Albany	Cck...	42° 6′	73° 47′	Fell 1859, Aug. 11.
Burlington	Otsego	Om...	42° 40′	75° 8′	Found 1819.
Cambria	Niagara	Of....	43° 13′	78° 45′	Found 1818.
Seneca Falls	Seneca	Om...	42° 57′	76° 58′	Found 1850.
Tomhannock Creek	Rensselaer	Cgb...	42° 52′	73° 36′	Found 1863.
NORTH CAROLINA:					
Asheville	Buncombe	Om...	35° 36′	82° 31′	Found 1839.
Black Mountain	Buncombe	Og....	35° 53′	80° 3′	Found 1839.
Bridgewater	Burke	Of....	35° 45′	81° 53′	Found 1890.
Castalia	Nash	Cgb...	36° 4′	78° 4′	Fell 1874, May 14.
Colfax	Rutherford	Om...	35° 18′	81° 45′	Found 1880.
Cross Roads	Wilson	Cg.....	35° 38′	78° 7′	Fell 1892, May 24.
Deep Springs	Rockingham	Db....	36° 20′	79° 35′	Found 1846.
Duel Hill	Madison	Og.....	35° 51′	82° 44′	Found 1873.
Ferguson	Haywood	Stone..	35° 36′	83° 0′	Fell 1889, July 18.
Flows	Cabarrus	Cga....	35° 18′	80° 33′	Fell 1849, Oct. 31.
Forsyth County	.....	Dn....	36° 8′	80° 20′	Found 1895.
Guilford County	.....	Om....	36° 4′	79° 48′	Des. 1822.
Hendersonville	Henderson	Stone..	35° 19′	82° 28′	Found 1901.
Jewell Hill	Madison	Of.....	35° 49′	82° 45′	Found 1854.
Lick Creek	Davidson	H.....	35° 40′	80° 12′	Found 1879.
Linville	Burke	Hch...	35° 48′	81° 55′	Found 1882.
Murphy	Cherokee	H.....	35° 6′	84° 2′	Found 1899.
Persimmon Creek	Cherokee	Offbp..	35° 3′	84° 4′	Found 1893.
Rich Mountain	Jackson	Cia....	35° 19′	83° 8′	Fell 1903, June 20.
Smith's Mountain	Rockingham	Of.....	36° 32′	79° 58′	Found 1863.
NORTH DAKOTA:					
Jamestown	Stutsman	Of.....	46° 42′	98° 34′	Found 1885.
Niagara	Grand Forks	Og.....	47° 58′	97° 52′	Found 1879.

[1] Central portion of State.

[2] About.

List of meteorites by States or countries—Continued.

	County.	Classification.	Latitude north.	Longitude west.	Remarks.
OHIO:					
Anderson Township	Hamilton	P	39° 10′	34° 18′	Des. 1884.
Cincinnati	Hamilton	Ds	39° 7′	84° 29′	Des. 1898.
Hopewell Mounds	Ross	Om	39° 10′	83° 20′	Des. 1902.
New Concord	Guernsey	Cia	39° 58′	81° 44′	Fell 1860, May 1.
Pricetown	Highland	Cw	33° 11′	83° 44′	Fell 1893. Feb. 13.
Wooster	Wayne	Om	40° 48′	81° 58′	Found 1858.
OREGON:					
Port Orford	Curry	P	42° 47′	124° 28′	Found 1859.
Willamette	Clackamas	Om	45° 22′	122° 35′	Found 1902.
PENNSYLVANIA:					
Bald Eagle	Lycoming	Om	41° 12′	77° 5′	Found 1891.
Mount Joy	Adams	Ogg	39° 44′	77° 20′	Found 1887.
Pittsburgh	Allegheny	Ogg	40° 27′	79° 57′	Found 1850.
SOUTH CAROLINA:					
Bishopville	Sumter	Chla	34° 12′	80° 18′	Fell 1843, Mar. 25.
Chesterville	Chester	Dn	34° 42′	81° 15′	Found 1847.
Laurens County		Off	34° 30′	82° 14′	Found 1857.
Lexington County		Og	33° 57′	81° 18′	Found 1880.
Ruff's Mountain	Newberry	Om	34° 15′	81° 21′	Found 1844.
SOUTH DAKOTA:					
Bath	Brown	Ccb	45° 27′	98° 19′	Fell 1892, Aug. 29.
Fort Pierre	Stanley	Om	44° 23′	100° 46′	Found 1856.
TENNESSEE:					
Babb's Mill	Greene	Db	36° 18′	82° 54′	Found 1842.
Carthage	Smith	Om	36° 20′	85° 56′	Found 1844.
Charlotte	Dickson	Of	36° 13′	87° 20′	Fell 1835. Aug. 1
Cleveland	Bradley	Om	35° 8′	84° 53′	Found 1860.
Coopertown	Robertson	Om	36° 25′	87° 0′	Found 1860.
Cosby Creek	Cooke	Og	35° 48′	83° 15′	Found 1837.
Crab Orchard	Cumberland	Mg	35° 53′	84° 48′	Found 1887.
Drake Creek	Sumner	Cwa	36° 18′	86° 34′	Fell 1827, May 9.
Jackson County		Om	36° 25′	85° 37′	Found 1846.
Jonesboro	Washington	Of	36° 16′	82° 30′	Found 1891.
Morristown	Hamblen	Mg	36° 9′	83° 24′	Found 1887.
Murfreesboro	Rutherford	Om	35° 50′	86° 20′	Found 1847.
Petersburg	Lincoln	Ho	35° 20′	86° 38′	Fell 1855, Aug. 5.
Smithville	Dekalb	Og	35° 55′	85° 46′	Found 1840.
Tazewell	Claiborne	Off	36° 27′	83° 48′	Found 1853.
Wallens Ridge	Claiborne	Og	36° 30′	83° 30′	Found 1887.
TEXAS:					
Bluff	Fayette	Ckb	29° 52′	96° 48′	Found 1878.
Carlton	Hamilton	Off	31° 50′	98° 10′	Found 1887.
Denton County		Om	33° 14′	97° 8′	Found 1856.
Estacado	Crosby	Cka	33° 35′	101° 25′	Found 1902.
Fort Duncan	Maverick	H	28° 35′	100° 24′	Found 1852.
Iredell	Bosque	H	31° 53′	97° 52′	Found 1898.
Kendall County		Hb	29° 24′	98° 30′	Found 1887.
MacKinney	Collin	Cs	33° 9′	96° 45′	Fell 1870.
Mart	McLennan	Off	31° 10′	96° 45′	Found 1898.
Pipe Creek	Bandera	Cka	29° 43′	98° 56′	Found 1887.
Red River		Om	32° 7′	95° 10′	Found 1808.
San Angelo	Tom Green	Om	31° 20′	100° 20′	Found 1897.
San Pedro Springs	Bexar	Cw	29° 27′	98° 27′	Found 1887.
Travis County		Cs	30° 20′	97° 29′	Found 1890.
Wichita County		Og	34° 0′	98° 40′	Found 1836.
UTAH:					
Salt Lake City	Salt Lake	Cgb	40° 58′	111° 25′	Found 1869.
VIRGINIA:					
Botetourt County		D	37° 30′	79° 50′	Found 1850.
Hopper	Henry	Om	36° 35′	79° 45′	Found 1889.
Indian Valley	Floyd	Hb	36° 58′	80° 39′	Found 1887.
Poplarhill	Giles	Of	37° 13′	80° 47′	Found 1852.
Richmond	Henrico	Cck	37° 29′	77° 28′	Fell 1828, June 4.
Staunton	Augusta	Om	38° 14′	79° 1′	Found 1858.
WEST VIRGINIA:					
Greenbrier County		Og	37° 52′	80° 18′	Found 1880.
Jennie's Creek	Wayne	Og	37° 53′	82° 22′	Found 1883.

List of meteorites by States or countries—Continued.

	County.	Classification.	Latitude north.	Longitude west.	Remarks.
WISCONSIN:					
Algoma	Kewaunee	Om...	44° 30′	87° 30′	Found 1887.
Hammond	St. Croix	Oh...	44° 55′	92° 22′	Found 1884.
Trenton	Washington	Om...	43° 20′	88° 12′	Found 1858.
Vernon County		Cka...	43° 30′	91° 10′	Fell 1865, Mar. 26.
WYOMING:					
Silver Crown	Laramie	Og...	41° 10′	105° 20′	Found 1887.
ONTARIO AND QUEBEC, CANADA:					
Chambord	Lake St. John	Om...	48° 35′	73° 8′	Found 1904.
Decewsville	Haldimand	Cw...	44° 56′	79° 55′	Fell 1887, Jan. 21.
Madoc	Hastings	Of...	44° 29′	77° 20′	Found 1854.
Shelburne	Grey	Cga...	44° 7′	80° 11′	Fell 1904, Aug. 13.
Thurlow	Hastings	Of...	44° 22′	77° 20′	Found 1895.
Welland	Welland	Om...	42° 59′	79° 14′	Found 1888.
	Territory or Province.				
ALASKA:					
Chilcat		Om...	59° 0′	135° 15′	Found 1881.
WESTERN CANADA:					
Beaver Creek	British Columbia	Cck...	51° 10′	117° 30′	Fell 1893, May 26.
Iron Creek	Saskatchewan	Om...	52° 40′	111° 50′	Found 1871.
GREENLAND:					
Cape York	Melville Bay	Om...	76° 12′	65° 0′	Found 1895.
	Country.				
CENTRAL AMERICA:					
Heredia	Costa Rica	Ccb...	10° 1′	84° 41′	Fell 1857, Apr. 1.
Rosario	Northern Honduras	Og...	14° 38′	88° 42′	Found 1897.
	State.				
MEXICO:					
Adargas	Chihuahua	Om...	26° 6′	105° 14′	Found 1780.
Amates	Guerrero	Om...	18° 30′	99° 22′	Found 1889.
Apoala	Oaxaca	Of...	17° 40′	97° 0′	Found 1889.
Arispe	Sonora	Ogg...	30° 15′	110° 0′	Found 1898.
Avilez	Durango	Cc...	24° 50′	103° 52′	Fell 1856, June.
Bacubirito	Sinaloa	Off...	26° 0′	107° 54′	Found 1871.
Bella Roca	Durango	Of...	24° 55′	105° 25′	Found 1888.
Bocas	San Luis Potosi	Cw...	22° 28′	101° 5′	Fell 1804, Nov. 24.
Cacaria	Durango	Oh...	24° 28′	104° 50′	Found 1867.
Casas Grandes	Chihuahua	Om...	30° 27′	107° 48′	Des. 1867.
Charcas	San Luis Potosi	Om...	23° 0′	100° 30′	Des. 1804.
Chichimeguilas	Zacatecas	Iron...			Found 1901.
Chupaderos	Chihuahua	Of...	27° 20′	105° 10	Found 1852.
Coahuila (State of)		H...	(1)	(1)	Found 1857.
Cosina	Guanajuato	Ck...	21° 7′	100° 34′	Fell 1844, Jan.
Descubridora	San Luis Potosi	Om...	23° 50′	101° 10′	Found 1780.
La Charca	Guanajuato	C...	20° 53′	100° 55′	Fell 1878, June 11.
Mazapil	Zacatecas	Om...	24° 35′	102° 15′	Fell 1885, Nov. 27.
Mezquital	Durango	Ds...	23° 40′	104° 28′	Des. 1868.
Misteca	Oaxaca	Om...	16° 45′	97° 4′	Des. 1804.
Moctezuma	Sonora	Om...	28° 49′	109° 40′	Found 1899
Morito	Chihuahua	Om...	27° 0′	106° 10′	Found 1600.
Pacula	Hidalgo	Cwb...	21° 3′	99° 18′	Fell 1881, June 18.
Rancho de la Pila	Durango	Om...	23° 15′	104° 0′	Des. 1804.
Rancho de la Presa	Michoacan	Cc...	19° 50′	100° 30′	Found 1899.
Rodeo	Durango	Of...	25° 20′	104° 40′	Found 1852.
Santa Apolonia	Tlaxcala	O...	19° 14′	98° 15′	Found 1872.
Sierra Blanca	Chihuahua	Og...	27° 8′	105° 22′	Found 1784.
Teocaltiche	Jalisco	O...	21° 25′	102° 27′	Found 1903.
Tlacotepec	Puebla	O...	18° 45′	97° 39	Found 1903.
Toluca	Mexico	Om...	19° 20′	99° 45′	Found 1784.
Tomatlan	Jalisco	Cc...	20° 17′	105° 12′	Fell 1879, Sept. 17.
Yanhuitlan	Oaxaca	Of...	17° 40′	97° 0′	Known 1830.
Zacatecas	Zacatecas	Obz...	22° 40′	102° 36′	Des. 1796.

[1] Central portion of State.

DESCRIPTION OF FALLS.

ADARGAS.

Sierra de los Adargas, Chihuahua, Mexico.
Here also Concepcion.
Latitude 26° 6′ N., longitude 105° 14′ W.
Iron. Medium octahedrite (Om) of Brezina.
Known for centuries; rediscovered 1780 (or 1784?).
Weight: 3,325 kgs. (7,315 lbs.), according to the label in the Mexican School of Mines.

The first account of this meteorite was given by Bartlett [2 a] as follows:

We came to a small stream, where, encompassed in a grove of cottonwoods, lay the pretty village (Concepcion) to which we were destined. On our arrival we stopped under the shade of some large trees, and dismounting at once discovered the object of our search, about 50 yards distant, at the corner of a large building. This was the residence of Don Juan Urquida (i. e., Urquidi), the proprietor of the hacienda and large estates adjoining, and formerly governor of the State. That no time might be lost, Doctor Webb immediately set to work with his hammer and cold chisels to cut off some pieces from the large mass of iron before us. This he found to be an undertaking of great labor in consequence of the extreme tenacity and hardness of the mass. After an hour's work with a man to assist him, he succeeded in cutting off 3 or 4 small pieces, which did not altogether weigh an ounce, and were barely sufficient for an analysis. Five chisels having been broken, the doctor had to desist from his labors, much to our regret, as we were desirous to obtain some specimens for cabinets. While this was going on, I took a couple of sketches of the mass showing opposite sides, and also took measurements; but the form was so irregular that these measurements can only aid in conveying an idea approximately of its bulk. Its greatest height is 46 inches; greatest width, 37 inches; circumference in thickest part, 8 feet 3 inches. Its estimated weight, according to Señor Urquida, is 3,853 pounds. While we were at work, Señor Urquida, the younger, the brother of Don Juan, came out. He said it was originally found about 3,000 varas (270 yards) from its present location, and had been moved at different periods by the people of the hacienda to the place where it now stands. It was brought hither with the design of putting it in a blacksmith's shop to be used as an anvil, although it had never been so employed. An attempt had been made to reduce it, by building a large fire around it and heating it to a white heat. But so intense was the heat from so large mass that the workmen could not approach it, and all their labor was lost. The expense of this operation was more than $100, and resulted in obtaining a piece of the metal large enough to work into a pair of spurs.

Smith,[3] writing in 1855 under the heading "Meteoric iron from Chihuahua, Mexico," quotes Bartlett's description and gives two figures of the mass. He states that the mass is at the Hacienda de Conception about 10 miles from Zapata.

Connolly,[7] in the Smithsonian Report for 1865, gives the following account:

In the State of Chihuahua, and at the hacienda of Don Juan Nepumocena Urquida, about 180 miles south of the city of Chihuahua, and directly on the road from the city to the city of Mexico, and 30 to 50 yards from the main road, is what is supposed to be a meteorite. I saw it nearly every year for 20 years, the last time in 1846. It is a large mass of solid iron, standing like a post in the earth, from which it projects about 4 feet. Its diameter at the surface of the ground is 2 to 3 feet. It diminishes in size toward the apex, which is irregularly rounded. The part above ground would weigh a ton or more. How far it is embedded in the earth had never been ascertained. Some small pieces, or chips, had been detached by cold chisels and carried off as curiosities, but these pieces were insignificant in point of size, and their removal has not disfigured the general mass as a specimen.

Simson [9] says of it:

About halfway between El Valle and Parral, on a bend of the Rio Florido, at a place called Concepcion, is a most splendid specimen of meteoric iron. It is 4 feet above ground, and almost pure in quality. It is from 2 to 3 feet one way by probably 2 to 5 feet the other, very regular in shape, and, where worn by the rubbing of hands, etc., of passers-by, is bright, and to all appearances is nearly pure metal. The steel hatchet cuts into it easily. It stood at the corner of the house, apparently to guard the corner from collisions of wagons and the like. The major-domo said that this meteorite had, as he had heard, fallen from the heavens, and had been brought from a distance, from a place where other specimens also existed. Such we found to be the prevailing account of this mass among the people of the place.

[a] The reference numbers refer to the bibliography following the description of each fall.

A further account is given by Urquidi [13], as follows in a letter to Professor Henry:

Nothing is known with certainty regarding the fall of this meteorite nor is it mentioned in the deed of the Hacienda Conception. There is an inscription engraved on the upper part of it which reads: "A 1600"; and the antiquated character of this inscription has created the general belief that it refers to the year in which the meteorite fell, or rather to that of its discovery, since historical tradition (not to speak of the absurd fable to the effect that Malinche let it fall, while transporting it hidden through the air, on account of a cock having crowed) only tells us that during the last century it was discovered buried in the sand on a piece of bushy land which had been drained, situated 800 yards south of the main house of the hacienda, whence it was taken about 100 yards off, where it remained a long time; and that in the year 1810, Don Manuel Concha, then administrator of the hacienda, removed it and placed it as a sign at the door of a blacksmith shop, situated about 15 yards from the south corner of the main house. There it was when I first knew it, in 1823, and from there my brothers and I managed to roll it to its present place, at the south corner of the main house. Lately it has been necessary to straighten it, as it has been leaning, in consequence of the sinking of the ground, or of the effects of a stroke of lightning in 1859, which also probably damaged the walls of the corner in question.

With much difficulty and after spoiling chisels of good steel, several pieces have been cut at different times, leaving a brilliant surface where separated. Even a bridle bit, knives, and some other small objects have been made of it. The blacksmiths assert that the iron is very ductile and malleable. It is said to consist almost entirely of iron, with a little nickel. The peculiar appearance of the many little holes seen in its surface show that at some time it was in a state of fusion, since such holes are identical with the cavities left by bursting bubbles.

In regard to its weight and dimensions, I copy what I find in some notes in my possession, which read thus: "From the above reckoning, it will be seen that the meteorite measures 39,299 cubic inches. Considering the metal as cast iron, the weight of which is to the weight of distilled water, frozen, as 72.070 is to 1,000 and that the cubic centimeter of such water weighs 20.031 grains, we may infer that the meteorite weighs 154.0132 arrobas." (One arroba is equivalent to 25 pounds.)

Wülfing [24] shows that the above weight in arrobas would be about 1,700 kg., while the cubic contents above given would weigh 5,000 kg.

Brezina [19] in 1885 classed the meteorite as an ataxite, but remarked that a new section was needed.

Castillo [20] gives the location of the Hacienda de Concepcion as 22 km. south of the valley of San Bartolome, now called Valle de Allende, or simply Allende, upon the road leading from the Hacienda de Rio Florido out of the Valle de San Bartolome. The meteorite, he says, has nearly the form of a parallelopipedon 1 meter long, 1 meter wide, and 0.4 meter high. He goes on to say:

By its submersion in water M. F. Urquidi has calculated that it has a volume of 403,365 c. c. Its density being 7.76, it has then a weight of 3,130 kg. It is riddled with cylindrical holes in part filled with troilite. M. F. Urquidi has stated in a letter to M. A. Urquidi, his uncle, that the meteorite was moved April 29, 1780, from the Sierra de las Adargas near Huejuquilla to Concepcion.

Castillo further states that the meteorite was at the time of his writing at the Hacienda de Concepcion, but that it would soon be moved to the School of Mines in Mexico.

His map shows the location of the mass near the Rio Concepcion.

Fletcher [21] gives the above accounts in full and also states that Don José de la Soto, the owner of the Hacienda of Chupaderos, informed him that the location of the Sierra de las Adargas was 8 or 9 leagues south of Jimenez.

Brezina [23] in 1895 adopts the name Adargas and places the meteorite among octahedrites with medium lamellæ. He rejects Castillo's (Fletcher's) suggestion that the irons of Morito and Adargas belong with Chupaderos, and gives a figure of an etched plate of Adargas to show its differences from Chupaderos and Morito. He states that uniting Adargas with Morito is prevented by the breadth of lamellæ of Adargas which is near that of the coarse octahedrites, while Chupaderos differs from both in the character of the tænite. He describes a section of Adargas received from Castillo as follows:

Strongly spotted, quite broad kamacite (1.3 mm.), similar to Misteca and to a piece obtained from Krantz as Toluca which I regard as Misteca. Tænite strongly developed; fields generally completely filled with combs, rarely with dark gray plessite. On the surface are projecting octahedral ridges weathered free as in Pila and Cranbourne. After etching, irregular, dark gray, mold-like spots appear everywhere.

The name of Adargas, used by Brezina has been adopted by later writers and is here used, although in the view of the present writer the name of Concepcion would on many accounts

be preferable. The locality of Adargas seems uncertain and the various accounts given by Urquidi indicate that none of them are based on positive evidence.

The main mass of the meteorite is now preserved in the School of Mines of the City of Mexico. A few hundred grams are distributed among collections, Vienna and Ward possessing the largest pieces. The distribution is, however, slight.

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ADMIRE.

Lyon County, Kansas.
Latitude 38° 30′ N., longitude 96° 25′ W.
Iron-stone. Pallasite. Rokicky group (Pr) of Brezina.
Found 1861; described 1902.
Known weight, 30 kgs. (66 lbs.). Weight of several masses not recorded.

This meteorite was first described by Merrill [1] as follows:

The first piece of this meteorite was plowed up about 1881 by Mr. W. Davis, of Admire, Kansas, the original mass weighing some 12 or 15 pounds. This was all broken up and lost, except some 432 grams. Later finds were made as follows:

Township.	Range.	Section.	Grams.
16	12	35	6,725
16	12	36	7,280
16	12	25	2,048
16	12	14	432
16	17	1	5,460

On casual inspection the masses have the appearance of ordinary limonite segregations and do not suggest meteoric origin. The specimens are deeply fissured and weathering has produced extensive alterations in the metallic portion of the rock. Lawrenceite was the first to yield, and following this, troilite and native iron, leaving the schreibersite standing in relief and quite conspicuous.

The first product of oxidation is a highly lustrous—on polished surfaces, blue—material which crushes down readily to a fine magnetic powder. On further exposure this goes over into ordinary limonite. Where oxidation has

gone on largely, the silicates are shattered, and veins of the oxidized material traverse them in every direction, producing a network of fine lines, which, in thin sections, show up with a pronounced blue reflection, at first scarcely distinguishable from the native iron itself. On breaking a mass open it is found to consist of metallic iron and chrysolite, both easily determined by the naked eye. A polished surface exhibits interesting structural peculiarities. The silicate mineral is chrysolite, which occurs in single crystals and aggregates of from 1 to 30 mm. in diameter, almost universally fractured, and many of them in a decidedly sharp, angular condition. The proportional amount of iron varies considerably, but as a rule constitutes one-third in bulk of the mass and performs the function of a binding or cementing constituent. Schreibersite is comparatively abundant and easily distinguished by its luster from the metallic iron. Troilite in sporadic patches is common, and chromite granules up to 1.5 mm. are fairly abundant. All but the last named are readily distinguished, on a polished surface, by the naked eye.

Lawrenceite exudes from the freshly cut surfaces here and there, and sometimes from the mass itself, but is most abundant along the line between the iron and the schreibersite plates. Polished surfaces quickly tarnish with it and must be protected by immersing in paraffin.

The chrysolite is brecciated, a condition due not to ordinary crushing, but to a sudden change from intense heat to cold or the reverse. Native iron, schreibersite and troilite often penetrate the silicates along these lines of fracture. The threads or veinlets of iron and schreibersite vary from a mere line to 1 or 2 mm., and indicate beyond question a solidification and perhaps reduction subsequent to the shattering of the crystals.

The metallic minerals often occur associated in a suggestive manner. Between a broad, white, outer band of nickeliferous iron and an inner area interspersed with blebs and dashes of iron, are always thin metallic plates, suggestive of tænite, but which chemical tests have shown to be invariably schreibersite. Often these areas quickly tarnish, after polishing, and exude a greenish material which reacts for chlorine and leaves the iron beneath, when washed off, of a dull black color and pitted. In such cases the material appears to be a spongy mass of metallic iron and iron chloride, presumably lawrenceite. Other portions seem like spongy mixtures of iron and iron sulphide, and others still, of pure iron.

Spicules of iron on the above described areas of iron and schreibersite are seen extending from points of attachment on the white metallic border inward or nearly across the interior dark gray area which is composed of lawrenceite. These spicules have all the appearance of incipient stages of crystallization, where the process has been arrested before completion. They resemble greatly in general appearance frost crystals on a window pane.

Etching does not produce the Widmannstätten figures, but brings out sharply the line of demarcation between the outer zone of iron and the inner, very brilliant, thin plate, which, though suggestive of tænite, proves to be schreibersite.

But one nickel-iron alloy exists, that most nearly corresponding to kamacite.

No chemical analysis of the mass as a whole was attempted, owing to its extremely coarse nature and the varying proportions of the metallic and silicate constituents. The chrysolite, however, yielded the following results (analysis by Tassin):

SiO_2	MgO	FeO	
39.14	47.63	13.185	=99.955

The chromite gave:

Cr_2O_3	FeO	MgO	SiO_2	
65.49	33.00	0.40	0.50	=100.39

The magnesia and silica of the above probably came from the included olivine. A portion of the iron relatively rich in the iron gave percentages corresponding to:

Nickeliferous iron	98.273
Schreibersite	1.645
Troilite	0.082
	100.000

Specific gravity, 3.95 to 4.2.

The meteorite is distributed among various collections.

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Aeriotopos, see Bear Creek.

Ainsa, see Tucson.

Alabama, 1834, see Limestone Creek.

Albany County, 1859, see Bethlehem.

Albuquerque, see Glorieta.

ALEXANDER COUNTY.

North Carolina.
Latitude 37° 57′ N., longitude 81° 13′ W.
Iron. Coarse octahedrite (Og) of Brezina; Braunite (type 3) of Meunier.
Found before 1875; described 1891.
Weight, assignable, 206 grams.

The first mention of this meteorite seems to have been by Venable [1] in his catalogue of North Carolina meteorites. He gives the locality as Cedar Creek, Alexander County, and states that—

This iron, weighing about 56 grams, was given by Gen. T. L. Clingman to Mr. S. C. H. Bailey, of New York, about the year 1875. It has not been analyzed, nor have I been able to learn more of its origin. The piece, Mr. Bailey writes, is evidently a fragment of a larger mass, and is sufficiently characteristic to be distinguishable from any other iron, though it more nearly resembles the Sarepta (Russia) iron.

Later the iron was described by Bailey [2] as follows:

This is a small piece of meteoric iron, evidently a fragment of a larger mass, found some years prior to 1875, in Alexander County, N. C. Nothing more definite is known as to the date and place of its fall.

It is rather smoothly rounded upon its broadest surface and, although wholly devoid of a proper crust, it is protected from further oxidation by the change produced by weathering. The surface shows no pittings.

Its structure is coarsely granular, or made up of polygonal fragments slightly adherent, with intervening thin films of schreibersite and cracks or veins of iron oxide, cementing the mass together. Small lumps of schreibersite with rounded outlines also sometimes appear. It cuts readily where free from schreibersite, takes a good polish, and is very light colored; but it does not show either Neumann lines or Widmannstätten figures upon the etched surface which turns black and slowly corrodes. The separate grains are quite malleable, but it is quite brittle in mass. It is probable that the fragment came from near the surface of the main mass, and the deeper interior portions, which have been protected from the soil and atmosphere may present different conditions. Specific gravity, 7.635.

Analysis (Venable):

Fe	Ni	Co	P	O (and loss)	
91.70	5.86	0.63	0.095	1.72	=100.00

The above analysis shows that the iron is a true meteorite if the locality is in truth a distinct one. Brezina [3] marks it "pseudometeorite?" and gives 1882 as the year of find. Wülfing [4] lists it in his appendix and gives a weight of 206 grams.

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AINSWORTH.

Brown County, Nebraska.
Latitude 42° 33′ N., longitude 99° 43′ W.
Iron. Coarse octahedrite (Og) of Brezina.
Found 1907; described 1908.
Weight: 10.65 kgs. (23.5 lbs.).

This meteorite was described by Howell [2] as follows:

This siderite, for which I propose the name of the town near which it was found, was purchased from Mr. J. C. Toliver. It was found last winter by one of Mr. W. G. Townsend's little boys, who called his father's attention to it as it lay partly buried in the sand beside a small creek in Brown County, Nebraska, about 6 miles northwest of Ainsworth. It measured approximately 4.5 by 6 by 7 inches, and weighed 23.5 pounds (10.65 kg.) with a specific gravity for the whole mass of 7.85. Two of the projections on one side are flattened, as if by pounding, but closer examination shows fine striæ running evenly across both surfaces, which are in the same plane, suggesting that the meteorite in falling may have glanced on a rock—making a slickensided surface. The most noticeable feature, however, is the presence, in a number of places on the surface, of bright unaltered troilite and schreibersite. This fact, in connection with the general freshness of the mass, would indicate that the "fall" was a comparatively recent one. A fractured surface on one of the sharp corners, and adjoining flat side, shows where perhaps 2 pounds had been broken from the mass antecedent to its burial, probably when it fell. The fractured corner exhibits the coarse octahedral structure, while the fractured side has the appearance of columnar structure, and there seems to be considerable tendency to columnar fracturing at this particular part of the iron, columnar-like pieces breaking from the sections as they were cut. Eight sections have been cut all parallel to the first—the one figured. The principal veins and the mixed figures of troilite and schrei-

bersite continue through them all; in addition, however, three typical nodules of troilite were encountered, which contrast strongly in color and form with those in which the schreibersite forms a prominent part. The sections etch very slowly; in time, however, lines appear which I did not hesitate to call Neumann lines until Mr. Tassin proved the iron to be an octahedrite, as was at first indicated by the fracture. These lines do not cross the veins referred to, and they are differently oriented in each of the blocks outlined by these veins, making the blocks appear as separate units. Mr. Tassin finds the structure of this iron to be unique, although in general appearance—especially in the irregular graphic segregations of schreibersite and troilite—it very closely resembles the São Julião, and in a less degree the Tombigbee River, and in some respects the Kendall County.

Mr. Wirt Tassin of the United States National Museum has devoted considerable time to the study of this iron and gives a summary of his results as follows:

"The iron here described is triangular in outline and shows a well-marked octahedral fracture on one edge, in fact the three edges of the section approximate three directions of an octahedron with the cut surface forming a fourth, giving the mass as a whole the appearance of a flattened octahedron. The surface as cut shows octahedral lamellæ of the largest size, so large that they are not at once apparent, as the specimen is not big enough to contain more than a few of them. Careful etching develops a surface having in places a mottled or dappled appearance. These mottlings when magnified under a vertical illumination show a definite octahedral structure and an etch figure directly comparable with that of other octahedrites, and may be regarded as centers of crystallization, which though minute, possess a well-defined lamellar structure and usually show the three characteristic alloys. The accessory constituent, shown in the figure as rows of crystals in relief, is unknown but is here assumed to be nickel-free iron. Such a structure, a most coarse octahedrite containing very minute octahedrites, has never before been observed by the writer. Contained in the mass as a whole are irregularly shaped segregations of troilite, in forms suggesting graphic characters. These troilite areas contain more or less carbon with grains of nickel-iron and phosphide of iron and they are commonly bounded with a thin wall of schreibersite. This compound also appears abundantly elsewhere on the surface, usually as bright points which, under the microscope, appear to be cross sections of the lath-like form known as rhabdite.

"The surface is also marked by veins or fissures of varying widths, certain of which are parallel to the several directions of the octahedron and form octahedral partings. These veins are commonly bounded by schreibersite and are filled with a carbonaceous material containing phosphorous, sulphur, and iron.

"The material available for analysis gave the following values:

Iron	92.22
Nickel	6.49
Cobalt	0.42
Copper	0.01
Phosphorus	−0.28
Sulphur	0.07
Chromium	−0.01
Silicon	0.049
Carbon	0.09
	99.639

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ALGOMA.

Kewaunee County, Wisconsin.
Latitude 44° 35′ N., longitude 87° 25′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1887; described 1905.
Weight 4 kgs. (9 lbs.).

This meteorite has been described wholly by Hobbs [1] as follows:

The meteoric iron which is here described was plowed up in the spring of 1887 on the farm of Mr. Henry Runke, about 4 miles west of Algoma post office, Ahnapee township, Kewaunee County, Wisconsin. The man who was guiding the plow noticed the heavy metal as it was turned up by the plow from the depth of but a few inches. Mr. Richard Runke, son of the farmer, was present and reports that the hired man placed the object upon a large stone and struck it a number of blows with another stone used as a sledge, in an attempt to break it. The evidence of this maltreatment it bears in a series of dents, especially upon its convex surface. Subsequently it was vigorously attacked with cold chisel and hammer. A curiosity merely, the Algoma iron remained about the farm on which it was found until March of the present year (1902), when Mr. Richard Runke, now a graduate of the University of Wisconsin and teacher of science in the Madison High School, brought it to the writer for examination. On being told that it was a meteorite and of considerable scientific value Mr. Runke very generously presented it to the university.

The spot at which the meteorite was plowed up can be located within a few feet, because of its proximity to a large pile of bowlders upon the lot. Mr. Runke has made some search in the vicinity and has also made extensive inquiries

among the neighbors, but as yet with no positive results. As will be shown below, there was reason to think that fragments might exist in the vicinity and the search was continued with the aid of dial compass and dip needle, but without success.

Size and Shape.

Instead of the usual irregular form or the paraboloid shape of some oriented meteorites (Hraschina, Allegan, Long Island), the Algoma iron is almost unique in having a discoid or shieldlike form. In the surface of greatest extension the outline is roughly elliptical, with major and minor axes 25 and 16.5 cm. From a thickness of about 2.5 cm. near the geometric center the disk varies irregularly, generally to smaller values and locally even to a knife edge at and near the circumference. The convex surface in the plane of the minor axis of its outline and its normal has a radius of curvature of about 21 cm., and the concave surface a considerably larger value, about 32 cm. The two broad surfaces are spoken of as the convex and concave surfaces, respectively, because the former invariably recedes near its margin (though concave at one place and in one plane near its center). The other surface is more nearly concave than convex, and in one plane (that of the minor axis and the normal) is distinctly concave.

Weight and Specific Gravity.

When brought to the university the Algoma iron weighed a little less than 9 pounds, or somewhat more than 4 kilograms (weighed with a spring balance). A small slice, in the widest place less than 3 cm. in width, was sawed from one end, and due to a misunderstanding of instructions a saw cut was made, running partly through the meteorite at a greater distance from the end. After suffering these losses the main meteorite mass now weighs 3,716 grams.

A block weighing a little over 39 grams, polished on two sides, after boiling in water for half an hour and cooling to room temperature, was weighed in the water, and then, after drying, in air by the suspension method. The result obtained for the specific gravity was 7.75.

Surfaces.

the convex surface.

Larger irregularities.—The convex surface, for reasons which will appear, designated the front of the meteorite (*Brustseite*), merits a careful consideration. Marks which this surface owes to its maltreatment subsequent to its discovery in 1887 are the dents from pounding with a sharp rock edge, the grooves from attack with a cold chisel and hammer, and the abraded surface and scratches which are the work of a file. In addition to these disfigurements, there are * * * relatively deep pits of markedly irregular outline which doubtless owe their origin to the fusion and removal of a mineral (schreibersite) more fusible than the nickel-iron itself. The manner in which such pits are formed is well illustrated by the small pitting cut through by the saw, at the bottom of which may be seen the schreibersite crystals separated by walls of swathing kamacite. One pit corresponds in position with a similar pit upon the back of the meteorite and doubtless was once continuous through the disk, as it may now be followed nearly through and appears to be choked for a short distance by the oxide scale which lines its walls.

The low fusibility of schreibersite is well known and was well brought out during the polishing of the section, the smaller crystals of schreibersite at once revealing their position by their fusion, due to the moderate frictional heat of grinding.

Larger shallow pittings, which more resemble the conventional "thumb marks," have doubtless been produced in a similar manner by fusion of schreibersite, combined with fusion and abrasion of the outer walls, since their sides toward the meteorite center possess the same steep, irregular slopes as the others, with some accumulation of oxide scale. Being located near the circumference of the disk, they lie within the zone of maximum erosion from the action of the compressed air, and the thin walls which presumably once separated them from the present circumference of the meteorite would be hardly able to withstand the erosive action.

The marginal area of the meteorite front, on which the "thumb mark" pittings are found (for convenience called the straighter margin) is in rather sharp contrast with the opposite front margin (the lobate margin). From the nearly plane central boss of elliptical shape (axes, 9 and 7 cm.) the surface of the disk slopes away sharply on the side of the larger pittings and is there also deeply furrowed in directions nearly radial. The lobate side recedes in more gradual curves, is marked by small and irregularly distributed pittings, and is covered with a thin film of oxide. Through this coating of oxide the nearly radial furrows and ridges which characterize the opposite margin can be followed without difficulty, though they are much less distinct, and the effect produced is altogether like that which would be expected if this side had lain in a moist soil while the other had received greater protection. The margin not covered by the oxide (that of the shallow pittings) shows a steely, metallic luster. Near the ends of the front the surface resembles that of the margin where the shallow pittings are found. The end opposite the saw section, however, projects to the front from the margin of the central boss before its surface recedes in the regular curves characteristic of other parts of the front. This suggests that the meteorite may have been bent in about its geometric center by a force acting normal to its surface.

The central boss of the front shows, even under the lens, little trace of the radial furrows, and then only in circumferential portions. On the straighter side, where the surface slopes away rapidly from this boss, the furrows begin with great distinctness at the line where the flat boss gives place to the backward slope.

Drift ridges and furrows.—The radial markings could perhaps better be described as ridges than as furrows; they are in reality the material left in sharp, knife-edge lines between very shallow furrows having nearly flat bottoms. The ridges have a basal thickness of a fifth to a tenth of a millimeter, and where best developed the intervening furrows widen from about a millimeter at the margin of the central boss to two millimeters at the present circumference of the

meteorite. Approximating to right lines the ridges appear to have been modified in their direction to some extent by the crystalline structure of the meteorite, but even where deviated from their initial direction the tendency to maintain rectilinear directions is apparent. They sometimes cross one another at extremely acute angles.

While at first sight the ridges would appear to be strictly radial, closer examination, especially when made by stretching a fine thread along them, reveals the fact that they are in reality slightly curved in a common direction, the radius of curvature diminishing as the circumference of the meteorite is approached. They represent, therefore, the arms of an Airy's spiral. This variation from a straight line is approximately 1 in 30 or 1 in 50, and is greatest where the slope from the central boss is the steepest. In only one instance was any variation from the common direction of curvature to the left (lævo-rotation) observable, and this was in the bottom of the larger of the two marginal pits, where for a short distance the curvature is reversed only to resume its regularity near the edge of the disk.

Surface markings due to crystalline structure.—Beneath the prominent drift scorings the lens seldom fails to reveal the crystalline structure of the metal in regular cross-linings of lesser prominence. These show to the best advantage in the bottom of the deepest marginal pit on the side nearest the center of the mass—in the "lee of the wall" of that side.

Fracture lines.—Perhaps in some way connected with the crystalline structure is the series of parallel cracks which course over the front of the meteorite in a direction about parallel to its greatest cross-diameter. These joint-like cracks are observable by the unaided eye * * *. In places they are crowded together, separated by rather uniform space intervals of 1 to 2 mm., and at times they are lined with oxide, especially on the more oxidized side of the front.

THE CONCAVE SURFACE.

"Thumb marks."—The generally concave surface of the meteorite, as already explained, is in sharp contrast with the convex surface or front. In general aspect it does not differ from the surface of the greater number of meteoric irons, and may be described as undulating, due to the presence of large and very shallow pits ("thumb marks") which coalesce with one another.

Oxide scale.—Over all this surface of the meteorite is a coating of oxide of iron which varies in thickness from less than 0.5 to about 1 mm. in thickness. Thickest on the side of the most protected hollow of the surface, it has scaled off locally and left a series of irregular depressions on the larger pittings of a second order of magnitude. As this edge is the one which corresponds to greater oxidation upon the front, it is probable that some small portion of the oxidation occurred subsequent to the fall, due to the unfavorable conditions for preservation as regards air and moisture.

On this surface of the meteorite there are no distinct markings observable which can by any probability be ascribed to erosive agencies within the aerosphere.

Infolding of edges.—Of some interest is the apparent folding back of the edges on the concave surface. This infolding of the edges appears to have been before observed, and is quite noticeable on the models of the meteorites from Puquios, Chile, and Rancho de la Pila, Mexico. The regular curving of both surfaces of the Algoma meteorite near the edges that are turned back favors the view that this phenomenon is a result of slight bending of the marginal area from the pressure of the compressed air on the front, the greater curvature of the front (over that of the back) being ascribed to the erosive action.

THE MARGINAL SURFACE.

The marginal surface of the meteorite in all cases where the front does not meet the back in a sharp line has a very hackly appearance and indicates with little doubt a fracture surface. The more irregular contour of the disk along its margin is for about half its length rounded off by the curved front surface meeting the thumb-marked rear surface. Elsewhere, however, it has just the appearance of the fracture surface of a malleable metal ruptured by tensile stresses, small fibers or horns of metal being still attached to the surface. The small V-shaped notches in the marginal contour are rather striking, and perhaps indicate that there was a shearing component of the stress by which the metal was ruptured. A very thin film of oxide quite unlike the scale upon the back covers the marginal area of fracture.

Composition and Texture.

CHEMICAL COMPOSITION OF METEORITE.

The chemical analysis of the Algoma iron was kindly undertaken at my request by Mr. Arthur A. Koch, laboratory assistant in quantitative analysis at the University of Wisconsin. Duplicate analyses were made of samples of 5 grams each. The material used for this purpose was in thin plates from the sawed cross section.

On dissolving in acid, evaporating to dryness, and redissolving, the residue was very slight. After weighing, this residue was treated with hydrofluoric acid, and no gritty substance remained. The analyses yielded results as follows, the iron being in the one case determined by the gravimetric and in the other by the volumetric method:

	1	2
Iron	88.60	88.64
Nickel	10.64	10.62
Cobalt	.77	.91
Phosphorus	.14	.16
Silica	.02	.02
Sulphur	Trace.	Trace.
Copper	None.	None.
Carbon	None.	None.
	100.17	100.35

WIDMANNSTÄTTEN FIGURES—THE TRIAD.

The Algoma meteorite is an octahedral siderite rich in kamacite and tænite and relatively poor in plessite. The kamacite bands are of three types: First, there are the relatively thick bands (0.6 to 1 mm.) which cover the space of the section in a fairly regular network; second, there are parallel series of perfectly contiguous finer bands (0.1 to 0.5 mm.) or Kämme, which completely fill the large areas (Cohen's Gescharrter Kamazit), and, lastly, there are the swathing bands about schreibersite (Wickelkamazit), which are usually of exceptional width and generally swollen and irregular as regards outlines. Gradations between these varieties occur, but the first two types are nevertheless very clearly marked in the general structure. The wickelkamazit frequently, though not always, produces a merely local swelling of the coarser bands. Tænite in jagged, irregular, and occasionally interrupted lines surrounds the kamacite of all types. The plessite is of the structureless variety (Fleckiger plessit).

NEUMANN LINES.

The kamacite bands when etched to any considerable depth reveal beautiful Neumann lines (Schraffirter Kamazit).

REICHENBACH'S LAMELLÆ—SCHREIBERSITE.

The schreibersite, which is prominent on etched surfaces by reason of its brilliant luster and its great susceptibility to oxidation, is arranged in rather distinct lines within the kamacite (Reichenbach's lamellæ). Always enveloped in kamacite, the largest area within the principal section has a wide aureole of kamacite about it. Being at the front surface of the meteorite, its fusion on one side has produced a noticeable depression on that surface. The hardness of this mineral was at the limit for the band saws used in cutting, even small areas of schreibersite sufficing to break them, and the hardness and brittleness were, moreover, serious obstacles in the way of securing well-polished surfaces for etching. The analysis shows that schreibersite comprises about 1 per cent of the entire mass of the meteorite. The mineral is developed in relatively thin plates, often of considerable size. The one which figures in all the sections was also encountered in the saw-cut which extends partly through the meteorite at a distance of 2 to 4 cm. from the sawed end, and must, therefore, have been not less than 3.5 or 4 cm. in length. The small branches of this crystal conform to the Reichenbach lines.

The fractures noticed on the front surface of the meteorite are seen in section on the forward margin of the etched surfaces as local, small dark lines extending into the mass for a depth of 1 or 2 mm. These are evidently filled with an oxidation product (perhaps the "Eisenglas" of some authors).

Owing to the markedly swollen character of the kamacite bands (Wulstiger Kamazit), it is difficult to determine whether any slight distortion, such as would be induced by bending of the disk, has occurred. It can hardly have been more than a few degrees at the most, since the general direction of the bands is well maintained across the section.

From the above it is clear that the Algoma iron belongs in the Charlotte group and is in many respects similar to Cohen's Charlotte type which fell in Charlotte, Dixon County, Tenn., in 1835. In all the respects of coarseness of structure, proportions of the members of the triad, varieties of kamacite and plessite, Neumann lines in kamacite, fractures and their fillings, resistance to weathering, Reichenbach's lamellæ, and their distribution in the network, it seems to correspond very closely; and one of Brezina and Cohen's plates would fairly well represent the Algoma iron. In composition also there is but slight variation. Both irons are remarkably free from the elements not constituting the triad. Algoma has 10.5 as against 8 per cent of nickel; Charlotte has 0.06 per cent of copper, which is not found in Algoma, and the latter has 0.15 per cent of phosphorus, which is absent in the former.

This meteorite is chiefly preserved at the University of Wisconsin.

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ALLEGAN.

Allegan County, Michigan.
Latitude 42° 32′ N., longitude 85° 53′ W.
Stone. Ornansite. Ornans group of spherical chondrites (Cco) of Brezina.
Fell 8 a. m., July 10, 1899.
Weight, 30.45 kgs (70 lbs.).

This stony meteorite fell on Thomas Hill, on the Saugatuck Road in Allegan, Michigan, about 8 a. m., July 10, 1899. The main mass of the stone weighed 62.5 pounds and the whole probably weighed not less than 70 pounds.

According to Mr. Walter Price, as quoted by H. L. Ward,[1] this stone came from the northwest and passed within 40 feet of where he was working, striking the ground about 10 rods beyond, in sand, and burying itself to the depth of about a foot and a half. The attention of observers, it is stated, was first attracted by a cannonlike report, followed by a rumbling sound

lasting about five minutes(?), which was followed, as the stone came nearer, by a hissing sound, compared to that of an engine blowing off steam. When first seen in the air the stone had the appearance of a black ball about the size of a man's fist. As it passed the observer "there seemed to be a blue streak behind it, about 6 feet long, which tapered back to a sharp point." The stone was dug up about five minutes after striking and is said to have been too hot for handling, necessitating its removal with a shovel. "The sand was hot for about 2 feet around where it struck." Messrs. H. Stern & Co., of Allegan, furnished corroborative evidence. They stated that the sand about the hole made by the meteor was quite warm for an hour after the fall, and that the stone itself was warm when placed in their shop window, some two and a half hours later.

The stone was flat on one side, forming the base, and rose to a rounded eminence on the upper side, which was probably foremost in its passage through the atmosphere, whereas the broad side was first to strike the ground. That the latter is true was shown by the adherence of grass stems and earth to this surface; whereas the former supposition is supported by the fact that the furrows on the outer crust, due to atmospheric friction, radiated from the rounded point where the crust was thinner. On the opposite side the crust was thicker, glassy, and enclosed only residual portions of unfused silicates; where the crust is thickest it is blebby, vesicular, and crowded with minute silicate crystals imperfectly secreted from the glassy base.

The grass, leaves, and earthy matter on the under side were not charred and showed no other indications of heat, only the black crust showed the effect of atmospheric friction.

To the unaided eye the fractured surface of this stone shows, according to Merrill[2], a quite even granular structure of gray color, and, on closer inspection, abundant beautifully spherulitic chondri, averaging not more than 1 or 2 mm. in diameter, in two cases nearly 5 mm. These beautifully spherulitic chondri are sometimes elongated or irregular, and may have pitted surfaces like those seen in compressed pebbles in conglomerates. The majority of them are dark gray in color, but some are greenish white. They are composed of both chrysolite and enstatite. Numerous brilliant metallic points of a silver-white color indicate the presence of disseminated iron. Viewed more closely the stone is seen to be made up of chondri, iron, and dark gray silicates, embedded in a light gray, ashy groundmass.

The stone is exceedingly friable, crumbling away readily between the thumb and fingers.

Under the microscope the thin section exhibits in a very marked degree the granular fragmental structure which sometimes characterizes chondritic meteorites, and which is regarded by Tschermak and some other authorities as indicative of a tuffaceous origin. Three types of chondri are observable: First, the ordinary enstatite chondri showing the eccentric, fan-shaped structure; second, those composed of chrysolites, sometimes quite idiomorphic, developed in a black glass; and, third, those which are apparently of enstatite but are almost completely structureless and of a greenish-white color.

These chondri are in most cases sharply differentiated from the groundmass and break away from it so readily as almost to prevent the preparation of thin sections. Many of them are fragmental and show by the condition of the fractured surfaces and the fact that the fragments do not fit together that the fractures antedate the consolidation of the mass.

The groundmass of the stone is a confused agglomerate of chrysolite and enstatite particles with interspersed metallic iron, iron sulphide, and chromic iron. In no case do the silicates occur with perfect crystallographic outlines, nearly all, both chrysolite and enstatite, being of fragmental nature and of varying size, ranging from particles of a millimeter in diameter down to the finest dust. The iron has the usual form of blebs and extremely irregular patches, serving as a cement. By reflected light it shows up in strong contrast with the dull brassy yellow sulphide, which is also irregular in form, sometimes isolated, and again associated with the iron. So far as observed, the sulphide never occurs in rounded blebs inclosed in the iron, as sometimes happens in large masses of meteoric iron. On the other hand, the silicate minerals do thus occur. Chromite in black specks is often associated with the sulphides, but does not present good crystal outlines in the section. No feldspar was found in it.

Analysis (Stokes)[2] of the metallic portion (23.06 per cent):

Fe	Ni	Co	Cu
21.09	1.81	0.15	0.01

Stony portion (76.94 per cent):

SiO_2	TiO_2	PiO_5	Al_2O_3	Cr_2O_3	FeO	FeS	MnO	NiO	CaO	MgO	K_2O	Na_2O	Li_2O
34.95	0.08	0.27	2.55	0.53	8.47	5.05	0.18	tr.	1.73	21.99	0.23	0.66	tr.

H_2O (110°)	H_2O (110°+)
0.06	0.19=100

Specific gravity (Merrill): 3.905.

The stone is in large part in the possession of the United States National Museum.

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2. 1900: Merrill and Stokes. Proc. Washington Acad. Sci., vol. 2, pp. 41–51. (Plates illustrate external appearance and fragmental and microscopic structure of stone.)

Allegheny County. See Pittsburgh.

Allegheny Mountains. See Greenbrier County.

Allen County. See Scottsville.

Amana. See Homestead.

AMATES.

Rancho de los Amates, north of Iguala, State of Guerrero, Mexico.
Here also Morelos.
Latitude 18° 30′ N., longitude 99° 22′ W.
Iron. Medium octabedrite (Om) of Brezina.
Found 1889.
Weight (assignable) 3 grams.

The only knowledge of this meteorite seems to be given in the mention by Castillo[1] as follows:

Morelos. Meteorite of Los Amates. This is a nodule of meteoric iron found among a number of specimens of minerals of iron coming from the Rancho de los Amates, a place situated upon the road from Mexico to Iguala and near the latter village.

Ward[2] gives Iguala as in the State of Guerrero, instead of Morelos. Ward possesses 3 grams. No other mention of weights seems to occur.

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2. 1904: Ward, Catalogue of the Ward-Coonley collection of meteorites, p. 3.

Ameca-Ameca. See Toluca.

AMECA AMECA.

Mexico, D. F., Mexico.
Latitude 19° 5′ N., longitude 98° 40′ W.
Iron.
Described 1889.
Weight not recorded.

The only description of this meteorite is by Castillo,[1] who says:

It is a small nodule of iron found in the village of Ameca Ameca. It is in the Mexican National Museum.

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ANDERSON.

Anderson township, Hamilton County, Ohio.
Here also Turner Mound and Little Miami.
Latitude 39° 10′ N., longitude 84° 18′ W.
Iron-stone. Pallasite, Krasnojarsk group (Pk) of Brezina.
Prehistoric, described 1884.
Weight, 847 grams, besides worked masses.

This meteorite was first described by Kinnicutt,[1] as follows:

In the spring of 1883 the curator of the Peabody Museum of American Archæology and Ethnology placed in my hands for examination certain specimens which had been "found on the altar of Mound No. 3 of the Turner group of earthworks in the Little Miami Valley, Ohio."

These specimens included portions of two ornaments made of iron, several others covered or overlaid with iron, and some separate pieces which were thought to be either an ore of iron, or, possibly, metallic iron.

These separate pieces were covered with cinders, small pieces of charcoal, pearls, broken ornaments made of shells, and other materials which were firmly attached to the coating of iron oxide, showing that these pieces had been subjected to a comparatively high temperature. On removing this foreign matter it was found that these specimens consisted mainly of metallic iron, which was of a steel gray color and easily malleable. That this iron was obtained by the reduction of an ore of iron seemed at first most probable; still there was a possibility that it might be of meteoric origin and a careful investigation was consequently undertaken.

The first piece taken for this purpose was of an irregular cubical shape, weighing 28 grams, and was evidently a detached piece of some larger mass. It was thickly coated with oxide of iron, had in general the appearance of limonnite, and could only with difficulty be cut or broken. The specific gravity was 6.42. A small piece perfectly freed from rust gave on analysis:

Iron	86.66
Nickel	12.67
Cobalt	.33
Copper	Trace.
Insoluble residue	.10
	99.76

A polished surface, when etched, gave well-marked Widmannstättian figures, and at one corner small crystals of olivine and bronzite could be easily identified under the microscope. Traces of a third mineral could also be detected on the polished surface, the exact nature of which I have not yet been able to determine.

The second specimen examined weighed 52 grams, was a square-shaped piece, and had evidently been hammered into its present form. Crystals of olivine could be easily detected inclosed within the iron. The specific gravity was found to be 6.51.

A piece of the iron thoroughly cleaned from rust gave on analysis:

Iron	88.37
Nickel	10.90
Cobalt	.44
Copper	Trace.
Phosphorous	Trace.
Insoluble residue	.12
	99.83

I did not consider it necessary to have a surface of this piece polished, as its general characteristics were the same as those of the first specimen examined.

The remaining separate pieces of iron, as well as the iron overlying the copper ornaments, were now carefully examined, and in each and every case the element nickel was shown to be present, and in most of the separate pieces crystals of olivine could be detected. This seems to prove conclusively that all the iron obtained from the mound was of meteoric origin, and in all probability portions of one large meteorite, which belongs, according to Daubree's classification, to the Syssiderites.

Two months after receiving the specimens above described the curator of the museum placed in my hands a mass of iron weighing 767.5 grams, which had been found "on the altar in Mound No. 4 of the Turner group.

This mass consisted principally of metallic iron and olivine; the crystals of olivine have a diameter of 5 to 10 mm., and are inclosed within the iron. The specific gravity was found by Professor Lattimore of Rochester, New York, to be 4.72.

A section of the stone was made and polished. The dark portions showing the size and shape of the crystals of olivine, which were of dark green, weighing from 200–800 milligrams and had a specific gravity of 3.33. An analysis of the olivine gave the following results:

SiO_2	40.02
FeO	14.06
MnO	.10
MgO	45.60
	99.78

The iron which inclosed these crystals had a specific gravity of 7.894 and gave by J. Lawrence Smith's process of analysis:

Iron	89.00
Nickel	10.65
Cobalt	.45
Copper	Trace.
Phosphorus	Trace.
Insoluble residue	.09
	100.19

A polished surface under the microscope showed, beside the crystals of olivine, small crystals of bronzite, which substance could also be easily detected by reflected light. Small quantities of schreibersite were also undoubtedly present, as shown by the traces of phosphorus found in the analysis of the iron.

The meteorite was entered in Brezina's 1885 Vienna catalogue [3] under the name of Anderson. On the discovery of the Eagle Station, Carroll County, meteorite, Kunz [5] suggested that the Turner mound material may have been obtained from this locality, but on later investigation and discovery of the Brenham, Kiowa County, pallasites he revised [6] this opinion and concluded it very probable that the iron was the same as Brenham.

Huntington [7] discussed this possibility and reached the conclusion that there was no reason for regarding them identical. He also discussed the possibility that the iron might have come from Krasnojarsk.

In the Vienna catalogue for 1895 Brezina [8] lists the meteorite still under the head of Anderson and suggests that with it belong probably also meteoric material from Daniel Harness Mound, Liberty Township, Scioto Valley, Ross County, Ohio, found in 1884; Till Porter Mound, latitude 38° 9′ N., longitude 84° 52′ W., Frankfort, Kentucky, found in 1889; the problematic Circleville, latitude 39° 32′ N., longitude 82° 52′ W., Ohio, described in 1820; and Marietta, latitude 39° 27′ N., longitude 81° 26′ W., Ohio, described in 1820; perhaps also Brenham.

Brezina in this catalogue further describes Anderson as showing rounded olivine in a strongly developed nickel-iron network, and the latter as showing swollen swathing kamacite 0.5–1 mm. broad, separated by tænite from gray plessite, which is free of skeleton structure. The pallasite has, he says, the greatest similarity in composition and structure with that of Brenham.

Wülfing [9] lists Anderson as belonging to Brenham, giving it, however, a separate bibliography. Ward [10] lists Anderson separately. This the present writer believes to be the best usage, as a local fall of the iron is quite probable. As Huntington [7] points out, it is quite as reasonable to suppose Krasnojarsk and Anderson of common origin as Brenham and Anderson. Unless there can be traced a more positive connection than has hitherto been done, it seems better to consider Anderson separate.

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8. 1895: Brezina. Wiener Sammlung, pp. 263–264 and 339.
9. 1897: Wülfing. Die Meteoriten in Sammlungen, p. 48.
10. 1904: Ward. Catalogue of the Ward-Coonley collection, p. 29.

ANDOVER.

Oxford County, Maine.
Latitude 44° 36′ N., longitude 70° 42′ W.
Stone. Spherulitic chondrite (Cc) of Brezina.
Fell August 5, 1898, 7.30 a. m.; described 1902.
Weight, 3.17 kgs. (7 lbs.).

This stone fell on the farm of Mr. Lincoln Dresser in Andover, Oxford County, Maine. Ward [1] gives the following account of its fall as stated by Dresser:

Mr. Dresser was within 25 feet of it when it fell. It came from the northwest at an angle of 75°. It was accompanied by a loud noise resembling that of a buzz saw, and left a trail of blue smoke. It was intensely hot when it struck and grazed a stone wall. In its fall it passed down through the branches of an elm tree, cutting many of them off as clearly as if done with a sharp knife. I supposed at the time it was a gaseous ball of fire, and thought it exploded, but after examination I found where it embedded itself in the earth to the depth of 2½ feet. I secured, by digging, a large piece weighing 7.5 pounds, and two or three small ones which were broken by striking the rock fence. This represents probably about half of the meteorite, as a large broken surface was apparent when it was found. People in the adjoining towns heard the peculiar buzzing noise, and a loud report, probably when it burst.

In June, 1902, Ward visited the spot where the stone fell, and states:

A sharp dent in the granite wall still showed freshly where the stone struck in its first impact. In falling it had passed through thickly set, small branches of an elm tree directly above. Mr. Dresser said that it was seeing these branches fall, cut off by the stone, which had changed his first impression of the gaseous character of the phenomenon. I obtained a portion of a branch 2 inches in diameter, half cut through by the meteorite. The large mass weighs 6.5 pounds. In general shape it is an irregular lengthened polygon like a flattened triangle, with the three points largely truncated. One side measures 7.75 by 4 inches; the opposite side, which was broken off by the fall, is of the same length, but 5.5 inches in measure at right angles. All other sides are well coated with a brownish-black crust, relieved by occasional patches of lighter brown. The crust is roughened by little, slightly raised pimples, often connected with very short ridges of the molten matter. On several sides are shallow pittings as large as the impressions of finger ends. Some of these are separated, others confluent, the latter, as is to be expected, all on the same side of the mass, having their depressed rim in the same direction or aspect. The broken side of the mass shows an interior of a light gray color, and is granular, with a few chondri of a much darker color. The whole mass is, in a fresh fracture, brilliant with points of nickeliferous iron sparsely interspersed with bronze-colored troilite.

The mass is now chiefly in the possession of Mr. Henry V. Poor, of Brookline, Mass.

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Annapolis, see Nanjemoy.

Anighito, see Cape York.

APOALA.

Oaxaca, Mexico.
Latitude 17° 40′ N., longitude 97° 0′ W.
Iron. Fine octahedrite (Of) of Brezina.
Weight, 85 kgs. (187 lbs.).

The first published mention of this meteorite seems to have been by Cohen [1] in 1901. He considered it at that time a piece of Misteca. He called attention to the markedly granular structure of the kamacite and compared the iron with Teposcolula and Moctezuma.

Ward's catalogue [2] of 1904 stated that the main mass of 85 kilos was "in the Museum of the Instituto Geologico, City of Mexico, not yet described." It was also stated that Apoala is 10 miles east of Coixtlhuaca.

Cohen [3] in 1905 further described the structure as follows:

According to a small piece, quite insufficient for a proper characterization, Apoala consists of short, puffy, irregularly bounded lamellæ, which are hatched only in exceptional cases. Where several lie close together, they are, as a rule, divided by small particles of plessite. The kamacite is composed of irregular grains of variable form, which are sometimes much less distinctly divided from one another than usual, attain a diameter of 0.1 mm., and show the same oriented luster. The tænite is markedly developed. The fields are less prominent than the bands and the smaller ones, which consist of compact, dark plessite, are sometimes intersected by one or more fine lamellæ which are united with the principal lamellæ, at one or both ends. In the larger fields the structure of the iron as a whole

is repeated; the small bands, which do not seem to be outgrowths of the larger, here also are composed of granular kamacite, but of a finer structure, and consequently appear darker. Schreibersite occurs in tolerably large crystals; in their neighborhood, as well as in the neighborhood of the natural surface, rust is readily developed.

The principal mass, as above stated, is in the City of Mexico.

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ARISPE.

15 miles N. W. of Arispe, Sonora, Mexico.
Here also Moctezuma (Berwerth).
Latitude 30° 15′ N., longitude 110° 0′ W.
Iron. Coarsest octahedrite (Ogg) of Brezina.
Found 1898; described 1902.
Weight, 18 kgs. (40 lbs.).

This meteorite is chiefly described by Ward.[1] An abstract of his account follows:

It was first discovered in 1898 by some Mexican mescaleros in the mountains some 15 miles northwest of Arispe, Sonora, Mexico. Thinking it to be silver, they hid it; but another party, following up the trail, stole it. After some time and some strife, personal and in the courts, the mass was acquired by Señor Canizaris at Cucurpe, in the Magdalena district. This gentleman had a hole drilled in it about half an inch in diameter by 2.5 inches in depth to test it for gold and silver. Finding no trace of either, the mass was laid aside. Its existence was subsequently referred to during a visit to that vicinity of Mr. A. F. Wuensch, a mining expert, who first recognized its meteoric character, and transported it to his home in Denver, Colorado. It is as irregular and shapeless as nearly all masses of meteoric iron, notably those from Mexico and the southwestern portions of the United States, where prolonged decomposition has in most cases corroded and broken down the sharper angles. The area of one side measures 16 by 12 by 9 inches, and shows no pittings, but a few shallow concavities, one of them nearly an inch across, doubtless due to decomposition since its fall. The opposite side measures 18 by 13.5 inches, with a thickness of 13 inches. This surface is covered with evenly distributed shallow pittings, ranging from 1.5 to 3 or 4 cm. in diameter, and having sharp outlines, indicating less decomposition on this surface.

On one side is a large semilunar depression, nearly 3 inches wide and deep and with nearly vertical walls on two sides and smooth surfaces free from ridges or pittings, indicating that the cavity was due to the decomposition of a great troilite nodule. This empty cavity is the most striking exterior feature of the mass.

A section surface shows numerous troilite nodules, up to 30 mm. in diameter, with a surrounding envelope of schreibersite, and sometimes containing small patches and angular fragments of nickeliferous iron and even, occasionally, masses of chromite 4 to 5 mm. in diameter. Polished or etched surfaces sometimes show arborescent groups of crystals, as large as 10 by 18 mm., of what is apparently cohenite. Numerous large masses of schreibersite are scattered through the iron 30 to 40 mm. in diameter; blades of the same material also occur, 3 mm. in width by 45 mm. in length. The Widmannstätten figures are sharp and clear, showing distinctly the octahedral structure of the iron. The kamacite plates are of unusual width, averaging 3 to 4 mm., and, in one instance, 195 mm. in length. The tænite films are comparatively small, but are noticeable from their difference in color as compared with the adjoining kamacite plates. The iron is further characterized by the almost entire absence of plessite.

A section across the meteorite shows it to belong to the class of brecciated siderites, and its individual pieces, or soldered fragments, are as large as the largest that have ever been recorded. A Y-shaped fissure divides a section into three areas. This fissure varies from a fine line in width to a broken vein of from 1 to 6 mm. in width and filled with troilite. This fracture and its filling with troilite probably occurred while the original mass was still in a state of fusion. The long kamacite plates do not match at the edges of this bifid fissure, but the three areas formed by it show them running in different directions, as if the three pieces had slipped out of their original position and been joined together again by different edges; or it may be that each of these three divisions represents an area of original crystallization.

Analysis (Whitfield):

Fe	92.268
Ni	7.040
	99.308

Specific gravity, 7.855.

Mr. J. M. Davison, of the Reynolds laboratory, Rochester, New York, noted the presence of a trace of platinum in the Arispe meteorite, also 1.84 per cent of schreibersite. He also

found some black particles of chromite in the center of a troilite nodule; with also, perhaps, a trace of cohenite.

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Arizona, 1851. See Tucson.

Arizona, 1891. See Canyon Diablo.

ARLINGTON.

Sibley County, Minnesota.
Latitude 44° 30′ N., longitude 93° 56′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1894; described 1896.
Weight, 9 kgs. (19¾ lbs.).

This meteorite has been described wholly by Winchell,[1] as follows:

This iron was found on the farm of Jos. Barry, sr., 2.5 miles northeast of Arlington, in Sibley County, Minnesota, in March, 1894. It was from the first suspected of being meteoric, but was not examined with care until the spring of 1896. A small piece having been broken off and submitted to Mr. Buck, of Arlington, it was forwarded to the writer for examination, after which the whole specimen was procured for the museum of the state university, where it is now preserved. The weight of the entire piece was 19.75 pounds. The following statement was given by W. J. McLeod, Esq., son-in-law of Mr. Barry:

"Found in Sibley County, Minnesota, on the farm of Joseph Barry, sr., 2.5 miles northeast of Arlington, in March, 1894. As it was found on a field that had long previously been cultivated, in the rich black soil and far from any highway, in a level country free from stone, it is confidently believed by the owners to be a meteor, and the boy who found it, Joe Barry, jr., expects it has some value as a curiosity."

Four and one-half pounds were broken by a sledge hammer from one corner, previous to which it was somewhat heart-shaped. The missing prong from this break was a precise counterpart in shape to the remaining one.

A figure, reduced to one-third the natural size, shows the shape of this iron, and the average thickness is about 0.5 inch. The upper (convex) surface is tolerably smooth, but has an indistinct, pock-marked aspect, due apparently to an internal crystalline structure, or to variation in the relative amounts of the ingredients. The lower surface which is about a plane, is, however, curiously pitted and rough. Some of the pits are so deep as to nearly pierce the specimen. They are smooth, and conico-thimble shaped. This surface has, moreover, a thin scale, or rust, which suggests a meteoric crust. This scale is best preserved in the depressions. The general appearance of the whole piece is that of a refuse piece of iron from a furnace.

On polishing a small portion of the upper surface and applying dilute nitric acid for a short time, the characteristic crystalline structure becomes beautifully expressed.

Throughout the etched surface sharp ridges stand up, thus outlining the coarse Widmanstätten structure. These elevations consist of some composition different from the depressions between them, for they not only resist the acid but they do not show the bright iron reflections that prevail in the depressions. These ridges are not entirely persistent and continuous, but disappear suddenly and rise again.

Between these long ridges the surface has, after etching, a brilliant metallic iron luster, which is due to the reflection of light from crystalline lamellæ. These lamellæ are apparently cleavages that are in the Widmanstätten bands, and they stand at different angles in different bands. They show that the bands themselves are crystalline throughout their substance. For instance, when placed in the direct sunlight the position at which some of the lamellæ are most illuminated by reflections is about 45° different from that in which the rest of the long lamellæ are illuminated. Another system of coarse lamellæ in like manner consists of two series. The broader upper band reflects light in a position at an angle of $\pm 90°$ from that at which the rest of the associated lamellæ reflect it. The same fact is observable in other parts of the etched surface.

These fine lamellæ, however, which might be called cleavages, and which characterize the metallic depressions, are crossed by a fine striation wholly independent of the long Widmanstätten structure. In most of these metallic surfaces this striation runs in the same direction, but in some of the bands it is at a different angle with the grand structure. This striation, in like manner, consists of dark ridges separating metallic grooves. They seem to differ from the coarse structure only in being much finer. Thus this iron has not only a coarse Widmanstätten crystallization, each band being, as it were, an individual crystal, but it has what might be considered a fine cleavage and a minute internal structure, which, throughout the separate crystals, maintains its direction and individuality.

These finer markings suggest those described by J. Lawrence Smith and named Laphamite marks, but they seem to differ from them in an important manner, if they be compared with the description published by Smith, yet there is no doubt that they both are due to a fine internal structure of the iron itself. The reflecting cleavages do not indicate

any variation in the composition of the iron and are more likely to represent the markings noted by Dr. Smith, but the dark elevated ridges, both coarse and fine, are apparently of a different chemical composition.

An analysis was made by F. F. Sharpless, and the following was the result:

Sulphur	None.
Silicon	None.
Manganese	None.
Chromium	Trace.
Copper	Trace.
Carbon (combined)	Trace.
Iron	90.781
Nickel	8.605
Cobalt	1.023
Phosphorus	0.045
	100.454

Mr. Sharpless adds:

"The only way in which I can account for the excess over 100 per cent, is that the composition does not appear to be uniform. Four determinations were made for iron, giving results varying from 90.58 per cent to 91.74 per cent. In the attempt to make a carbon determination the variation in composition was also noticed. Of three samples, weighing about 3 grams each, treated with potassium-copper chloride, one sample gave a particle of carbon much larger than a pinhead, one sample gave two small specks, while the third dissolved without giving a trace of carbon. When treated with hydrochloric acid all samples, with the exception of one, dissolved without giving evidence of combined carbon; this one sample gave a very strong odor resembling that given off when dissolving steel in hydrochloric acid.

"About 3 grams were used in making the test for the metals noted as 'none' or 'trace,' or sufficient to be sure that the results given are very nearly correct.

"This supposed variation in composition is in keeping with the spotted appearance of the weathered convex surface of the specimen."

The iron is chiefly in the possession of the University of Minnesota.

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Asheville, 1854. See Jewell Hill.

ASHEVILLE.

Buncombe County, North Carolina.

Here also Asheville; Asheville, 1839; Baird's farm; Baird's plantation; and Buncombe County, 1839.

Latitude, 35° 36′ N., longitude, 82° 31′ W.

Iron. Medium octahedrite (Om) of Brezina. Agramite (type 21) of Meunier.

Known since 1839; described 1839.

Weight 9 to 10 ounces. Detached from mass "the size of a man's head."

The first account of this meteorite was given by Shepard [1] as follows:

A specimen of supposed native iron was lately presented to me by Dr. J. F. E. Hardy, for examination, accompanied with the observation that it was not completely soluble in acids. It weighed between 9 and 10 ounces; and had been detached from a rounded mass nearly as large as a man's head, which mass was found loose in the soil, about 5 miles west of Asheville village, near the southwestern base of an elevation of land 500 feet high. It was the opinion of Dr. Hardy that other masses existed at the same place.

The shape of the specimen in hand evinces a distinct crystalline structure, approaching that of a flattened octahedron. Its surface presents a dissected, or pitted appearance, occasioned by the removal of portions of the external laminæ during its separation from the original mass. The cells and cavities are perfectly geometrical in shape, being either rhomboidal, tetrahedral, or in the figure of four-sided pyramids. Indeed, the resemblance of the mass in this respect to that of an imperfectly formed crystal of alum is very striking.

It requires the application of numerous and powerful blows to disengage fragments from the specimen. The hammer slightly indents the surface; and at length loosens sections of the external laminæ, which may be detached by the aid of a forceps. Their shape is commonly that of an acute rhomboid, considerably flattened in its dimensions; but they are capable of an easy division into regular octahedrons and tetrahedrons, whose exactness of form rivals the cleavage-crystals of fluor. Some of the plates will separate into leaves nearly as thin as mica, which substance they

even resemble in color (being silver-white, inclining to steel gray), and are slightly elastic, though when twisted up, they remain as a piece of thin iron would do under the like circumstances. The shape of the thinnest fragments is as regular in outline as the layers of the most highly crystalline fluor, and are delicately striated in every direction in accordance with the octahedral cleavages.

Prior to the separation of any fragments, the surface of the specimen did not afford the metallic luster; but was coated with a thin blebby pellicle, apparently of hydrous peroxide of iron. Those surfaces which have been recently developed lose their silvery gray luster in the course of a few weeks, but without any sensible attraction of moisture from the atmosphere.

Its specific gravity varies from 6.5 to 7.5; indeed one fragment mounted as high as 8. This diversity of result is no doubt dependent on the compression of the fragments produced during their separation from the specimen.

The methods of analysis are then given in great detail by Shepard, and the following result was obtained:

Fe	Ni	Si	Cl	Cr, S, Co, As	
96.5	2.6	0.5	0.2	traces	=99.8

Eight years later Shepard [3] made a second mention of the meteorite as follows:

Asheville (Baird's Plantation, near French Broad River, 6 miles north of Asheville), Buncombe County, North Carolina. As this county has of late afforded two other localities of meteoric iron, I have taken pains to ascertain as nearly as possible the exact position of each. The Hon. T. J. Clingman informs me that this locality is 6 miles north of Asheville on the estate of Col. Baird, who is of the opinion that other fragments may there be found, as he has within two years observed small pieces of rusty iron in the same field from which Dr. Hardy's mass was obtained. Further experiments on the composition of this iron enable me to add to what was before made known that it contains cobalt, magnesium, and phosphorus; and that the nickel is sometimes present in a ratio as high as 5 per cent, while the silicon is considerably below 0.5 per cent, as formerly quoted.

Brezina [12] in 1885 placed this meteorite among the fine octahedrites and described the structure as follows:

Bands 0.6 mm. wide, kamacite somewhat hatched but at the same time granulated, plessite dark, schreibersite plates in kamacite abundant but irregularly distributed.

In 1895 [13] he changed this meteorite with others of the Hraschina group to the medium octahedrites.

The small quantity known of the meteorite is distributed. Vienna possesses 271 grams, Tübingen 171 grams.

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13. 1895: Brezina. Wiener Sammlung, pp. 268, 272, 300, and 329.

AUBURN.

Lee County (formerly Macon County), Alabama.
Here also Macon County.
Iron. Hexahedrite (H) of Brezina.
Found 1867; described 1869.
Weight, 3.5 kgs. (8 lbs.).

The original mass was ploughed up, prior to its being brought to public notice in 1868, in the neighborhood of East Alabama College, having been overlooked in the collection of Prof. J. Darby of this institution until 1868.

Professor Darby described the mass as consisting of agglutinated, irregularly shaped concretions, as if suddenly compressed together into a single rounded mass from a previous state of separation.

Professor Darby states, as quoted by Shepard:[1]

The man who brought it to me (and who was its discoverer) had taken it, without my knowledge, to a blacksmith's shop, where in the cold state it was broken in two upon an anvil by means of a sledge hammer. Originally it must have been nearly globular in form. The surfaces produced by the separation had, when I received the specimen, a metallic luster. The finder made known to me the exact spot where he had ploughed it up. It was on what is known as the Daniel plantation, about three quarters of a mile west of our college building, and near the eastern edge of a field, just across a branch (a small stream). I have searched in the region indicated for further specimens without effect, but have instructed the negroes to bring to me anything unusual which they may hereafter discover. The name of the man who found the mass and his present address are unknown.

According to Shepard[1]—

The surface of the fracture, or separation, is coarsely granular, exhibiting large irregularly shaped concretions, which show only obscure traces of octahedral cleavage. The former metallic luster is now replaced by a rusty brown film; while numerous cracks or chinks are observable, not merely separating the concretions, but often traversing the mass of each individual. Indeed the entire specimen is thus cracked up and subdivided by these open veins as if it had been shattered when in a semifused state by striking against a rock at the time of its fall. So imperfect is the cohesion at present that it would not be very difficult to break it into pieces (from the size of a large pea up to that of an almond) by vigorous blows from a sledge hammer. Some of these concretions are partially stalactitic, tuberose, or submammillary, as if a secondary softening or fusion of the iron had taken place at the time of its descent.

The larger concretions have a tendency to separate into smaller ones of the size of peas, whose figure, however, is that of the granular individuals of magnetite and pyrites, except perhaps, in the tendency to elongation in the concretion which occasionally passes into the subcolumnar structure. One single troilite globule half an inch in diameter is visible upon the fractured surface of the mass. It is compact in texture and yellowish brown in color. A polished surface half an inch square on being etched gave a series of markings extremely fine and delicate in their dimensions, and requiring a strong light, with the aid of a microscope, to be seen with distinctness. The first character that displays itself is that of a mesh or network, arising from the polygonal boundaries of the granular concretions. The areas within these lines or edges (which are exceedingly thin) have a glittering luster when held at a fixed angle to the light, though this angle often varies for different concretions. The second character of interest is the finely striated surface of each concretion, one set of lines being perfectly straight and equidistant, while a second set, less distinct, cross these at right angles. The final peculiarity of the markings is that these fine striæ are wholly made up of dots or beads, which are arranged in almost absolute contact, and are therefore to be regarded as consisting wholly of sections of rhabdite needles, while on the other hand, the mesh-like markings first noticed are composed of plates of schreibersite.

The iron is classified by Brezina[5] as a normal hexahedrite. Analysis by Shepard[1] of about 2 grams gave:

Fe.	Ni.	P.	Insol.	Mg., Ca., Si., & loss	
94.58	3.015	0.129	0.523	1.753	= 100

Sp. gr., 7.0–7.17 (mean 7.05).

Shepard notes that neither cobalt, tin, nor copper was detected in this iron, a statement which Smith[2] criticises as questionable. Cohen[4] also remarks that Shepard's analysis of Auburn needs revision.

Cohen[6] gives a further description and analysis as follows:

According to the description of Shepard it seems probable that Auburn should be considered a granular hexahedrite, but since neither the piece in Vienna, nor the material accessible to me indicates such a structure I place Auburn among the normal hexahedrites. It etches easily and shows abundant Neumann lines first visible under the lens. These lines frequently intersect and, as usual, some systems are distinguished by their length. Numerous uniformly distributed pits are present which may be referred in considerable number to rhabdite lying perpendicular to the plane of the section. Further, there appear on an etched surface, dull, dark, dimly bounded spots. Minute, dull, dark flakes which could not be further determined lie between the pits. They are, perhaps, carbonaceous particles. Larger inclusions of schreibersite are only sparingly present in the form of grains and rod-like crystals. Particles of iron glass lie on the edge, and a thin rust crust forms the natural surface. Since single spots in the neighborhood of the latter rust easily, the iron can not be, as Shepard states, free from chlorine.

Analysis by Hildebrand:[6]

Fe.	Ni.	Co.	Cu.	Cr.	P.	S.	
94.49	4.67	1.03	0.101	0.024	0.46	0.002	=100.777

The iron of Auburn is somewhat distributed, but the whereabouts of much of the originally reported quantity is not known.

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Augusta, 1848. See Castine.

Augusta County. See Staunton.

AVILEZ.

Near Cuençamé, Durango, Mexico.
Latitude, 24° 50′ N.; longitude, 104° 34′ W.
Stone. Spherulitic chondrite (Cc) of Brezina.
Fell June, 1856; described 1867.
Weight 236 grams (0.5 lbs.).

This meteorite was first mentioned by Wöhler [1] as a gift to the University collection at Göttingen received from Bremen. It was a stone brought from Mexico by Julius Hildebrand, who lived several years at Durango. According to a verbal statement made by Hildebrand to Wöhler, he obtained the stone soon after its fall in the summer of 1855 or 1856 from an acquaintance who lived at Cuençamé, about 30 miles northwest of Durango. This gentleman had heard from the natives of that place that stones had fallen from heaven upon the estate of Avilez in the vicinity of Cuençamé, and lay buried deep in the earth. This stone was still hot when dug up, but as it was supposed to be of no value, it was thrown away again. At the instance of this gentleman one of the pieces was found again and brought to him, and he sent it to Hildebrand. The usual fire-phenomena seem not to have been observed by the people.

The stone obtained by Hildebrand weighed 146 grams. It was evidently a fragment of a larger stone, apparently broken from the corner of the original. It was covered on three sides with a black, dull, wavy crust. The interior was gray, fine grained, and enclosed here and there brighter particles and chondri. It contained unequally distributed grains of metallic iron and strongly affected the magnetic needle.

Burkart [3] pointed out that Cuençamé does not lie northwest, but 20 leagues northeast of Durango, and that it was not an estate, as Buchner stated, but a mining village and chief place of the region of the same name, which, according to the map of Garcia y Cubas, lies 24° 40′ N. and 4° 8′ W. of Mexico.

Avilez was formerly set down as Cg by Tschermak, but Brezina [10] convinced himself that it belonged to Cc.

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Austin, 1836. See Wichita County.

Austin, 1856. See Denton County.

BABB'S MILL.

Greene County, Tennessee.
Here also Green County.
Latitude 36° 18′ N., longitude 82° 52′ W.
Iron. Babb's Mill ataxite (Db) of Brezina; Braunite (type 3) of Meunier.
Mentioned 1842; described 1845.
Weight 136–141 kgs. (300–310 lbs.).

Of the Babb's Mill, Greene County, Tennessee, meteorite, two finds are known; one was described by Troost in 1845 as Babb's Mill, the other by Blake in 1886 as Green County. Since, however, the former is also known in the literature as Green County, the two irons may here be denoted as the Troost iron and the Blake iron, in order to avoid mistake.

The Troost iron, according to Troost,[1] was ploughed up in a field near Babb's Mill some time in 1842. It was irregular in shape and weighed about 14 pounds. It had the appearance of having been melted and had been tested for silver. Its color was whiter than that of pure iron and it was highly malleable. Pittings characterized its surface.

Shepard's [2] description of this mass does not altogether agree with that of Troost; according to him two pieces of some 5¾ and 2¾ kg. were found, of which only the former was heated and divided, while the second came into his possession entire and unchanged and was figured by him. He gives the following characteristics: Yellowish-brown crust, conspicuous saucer-like depressions, fine grained, compact, taking good polish, lighter than steel, specific gravity 7.548, fine-grained fracture with silvery luster, after etching small bright specks appearing in irregular distribution.

Clark [3] gives the specific gravity as 7.839 and furnishes an analysis from filings.

Reichenbach [9] compares Babb's Mill with the Cape iron. Like the latter it consists, he says, apparently of plessite; it is dark gray, dull, without figures, and poor in inclusions, of which he mentions patches (of lamprite), fine needles (of crystalline tænite), as well as traces of kamacite.

Rose [11] also calls attention to its similarity with the Cape iron. Half of the plate appears, he says, dark gray, the other half brighter, and both shades, which run into one another, show the same changes in color tones according to the change in the position of the piece, as in the case of the Cape iron, but straight striping is not visible to the naked eye. Glistening inclusions occur in the form of crooked lines.

In 1884 Meunier [15] referred Babb's Mill to his Caillite group, which consists of a mixture of kamacite and tænite, and in 1896 he classified it with Braunite (Braunine $Fe_{16}Ni$) and in opposition to his earlier statement characterized it as homogenous and wanting in rhabdite.

In 1885 Brezina [16] identified Babb's Mill with the Cape iron group under the supposition that in larger sections than those before him it would, like the Cape iron, show bands, since, upon the whole, the physical and chemical characteristics were quite similar.

In 1886 Huntington [18] states in the same work, in one place, that an authentic piece in the Harvard College collection shows distinct Widmannstätten figures, while in another place he says the iron appears to be entirely homogenous. Since in his catalogue a year later he emphasizes the absence of all figures, the first statement may be attributed to an error or to an exchange of labels.

In 1892 a new analysis was published by Cohen [24] which confirmed the high content of nickel and cobalt found by Clark. The material at hand at that time did not suffice for an examination of the structure.

The second Babb's Mill mass was first described by Blake.[10] According to him it was found by a farmer in Green County, Tennessee, while plowing. It was completely buried in the earth, and there was nothing known as to the time of its fall. In the year 1876 it was sent with the minerals of Tennessee to the Centennial Exposition at Philadelphia, Pennsylvania, and then came into the possession of Mr. Blake.

Blake goes on to say:

It weighed 290 pounds (639.36 kg.), its original weight having been probably 300 pounds. It was reduced by cutting small portions from the ends of the iron and by exfoliation. Its form was its most striking visible peculiarity, it being an extremely regular long ellipsoid, tapering at each end to a flattened point, but having throughout its length an ellipsoidal section. It thus resembled somewhat the form of a flattened cigar.

Its dimensions were:

	Inches.	Meters.
Length	36	0.9144
Breadth	10	0.2540
Thickness	6	0.1524
Circumference	24	0.5991

It had probably been shortened about 3 to 6 inches by cutting off pieces from the ends. The surface was scaly and rusty, but is in general smooth and evenly curved, with the exception of several cup-shaped indentations or depressions, one of which, near one edge, gives the inward curvature in an elliptical outline. One of the depressions was nearly 3 inches broad and 1 inch in depth. These depressions did not seem to be due to the weathering out of more or less globular inclusions, such as troilite or schreibersite, but rather to the unequal exfoliation. The mass when struck by a hammer was remarkably sonorous and seems to be very compact and sound throughout.

The oxidized crust was in some places very thin, and a few strokes of a file developed the unchanged bright iron below; but in other parts of the mass the crust was found to be much thicker, especially after the meteorite had stood unmoved for several years. Flakes as broad as the hand and nearly 0.25 inch in thickness have been scaled off from the lower side. This scaling was the result of the gradual oxidation of the surface of the iron by the deliquescence of included iron protochloride, as shown by the abundant reactions for chlorine and the constant accumulations of moisture, especially upon the under surface of the iron. This deliquescence for several years was sufficient to cause drops of perchloride of iron to form and fall off at times upon the support below. The heavier of the oxidized crusts exhibited thin successive layers with smooth mammillated surfaces like the surface of limonite. They consisted of a mixture of hydrous sesquioxide of iron and magnetic oxide. They affected the magnetic needle and exhibited feeble polarity, as some fragments of the bright iron also did, but this might have been in consequence of the presence of an invisible scale of the magnetic oxide. The exudation of moisture seemed to be greatest from small seams, which on cutting into the iron were found to extend for 0.5 inch or more below the surface and were filled up with dark and hard magnetic oxide. Freshly cut surfaces of the iron, when laid upon a sheet of white paper, soon caused rusty spots, and moisture accumulated upon the surface, particularly in damp weather. This constant exfoliation of the mass perhaps gives an explanation of its peculiar symmetrical form. It may be regarded as the kernel or residuary nodule of a much larger and probably much more irregularly shaped mass.

The iron could be readily cut by a saw with oil and it works well under a file, giving a uniform dense surface without any signs of inclusions or of crystalline structure. The surface of fracture exhibited a fine granular structure, but with no crystalline facets. It was perfectly malleable; thin, fin-shaped projections could be readily bent back and forth repeatedly without cracking. A fragment heated to redness and quenched in cold water was not perceptibly hardened, and could be, as before, spread into thin sheets under the hammer, without impairing its malleability. The metal took a high mirrorlike polish, but yielded no structural markings on etching. The iron dissolved equally on all sides leaving a delicate velvety or frosted surface indicating a very even and fine granular structure.

According to Brezina [22] the iron was already known in 1818, but was lost sight of until 1876. Upon its arrival at Vienna the block weighed 131 kg.; the portions cut off from the pointed ends being estimated at 5–10 kg. In this publication Brezina holds that from its form the iron must have been an inclusion in a large meteorite, and instances a cylindrical inclusion in Bolson de Mapimi. He emphasizes the fact that the form can not be accounted for on the ground either of fusion in the atmosphere or of weathering by lying on the ground. The interior is compact, with insignificant scattered lumps and needles.

In 1895, Brezina [27] added that the Blake iron and Troost iron correspond perfectly. Both were referred by him to the ataxites, and, indeed, to the rather heterogeneous group of Babbs Mill. The very soft iron becomes dull by etching, with a velvetlike luster; the Blake iron is distinguished by many irregularly directed, straight or less frequently crumpled cracks, which appear to be due to weathering.

Cohen and Weinschenk [23] published in 1891 a new analysis, which gave an essentially different result from that obtained by Blake; among other things, it showed that cobalt was never wanting, as was especially emphasized by the latter. On a very small quantity of material, small angular rust spots appeared which were renewed quickly on a perfectly compact-appearing, freshly polished surface, and indeed always occupied the same spot and exactly the same

space. Small splinters were present on the inclusions, with apparently rectangular orientation to one another.

Analyses: 1 to 4, Troost iron; 5 and 6, Blake iron.

	1. Troost.	2. Shepard.	3. Clark.	4. Cohen.	5. Blake.	6. Cohen and Weinschenk.
Specific gravity	-----	7.548	7.839	------	7.858	------
Fe	87.16	85.30	80.59	81.54	91.42	86.30
Ni	9.76	14.70	17.10	17.74	7.95	12.58
Co	-----	------	2.04	1.26	-----	1.66
Cu	-----	------	-----	------	-----	------
Ca	-----	trace.	-----	------	-----	------
Mg	-----	trace.	-----	------	-----	------
Al	-----	trace.	-----	------	-----	------
P	-----	------	-----	0.11	-----	------
Rhbdi te	-----	------	0.12	0.05	-----	------
	96.92	100.00	99.85	100.70	99.37	100.54

Since, according to the statement of Brezina, the irons do not differ structurally, while the analyses gave very various results, Cohen investigated sections from both ends of the Blake iron. A few small fragments and a section weighing 392 grams, with a cut surface of 52.5 sq. cm. were used from one end of the cigar-shaped mass; and from the other end two sections with cut surfaces of 8.5 sq. cm. and 10 sq. cm.; from the Troost iron two sections of 16 grams weight together, and cut surfaces of 6 sq. cm. each were used.

Structurally, all these sections corresponded exactly. By weak etching the nickel-iron took on a varnish-like luster, characteristic for the most part of ataxites rich in nickel. The etched surface appeared homogenous to the unaided eye. By strong magnification, however, a structure made up of grains 0.01 mm. in size could be seen; moreover, tiny, glistening points also appeared. By stronger etching the cut surface became dull, with a velvet-like sheen, on account of the diffuse reflection of the light on the numerous small lumps which varied in size from 0.01 to 0.03 mm. A division into distinct grains did not, however, occur, and in general the etching surface remained of an unusually homogenous structure. The glistening particles in question may, in reflected light, be somewhat enlarged and appear to be very regularly distributed. Whether etching pits were present or whether it was the reflection of an uneven surface which the etching has made manifest was not easily determined; but the latter was the more probable. Disregarding the absence of etching bands, the etching surface is suggestive of that of the Cape iron, as Reichenbach and Rose have previously shown.

Of subsidiary material only a round kernel of graphite of 3 mm. in size occurs, in a section of the Vienna mass. Of the needles which Reichenbach mentions, and the splinters which Cohen thought he observed in the earlier investigation of this meteorite, nothing has been noted in the later more comprehensive material examined. Troost also emphasized the absence of all inclusions. Babbs Mill was the most homogenous nickel-iron and the poorest in subsidiary material known to Cohen.

The same sections of both lumps which were taken from near the original surface of the meteorite contained fine cracks running out in very irregular directions from the neighborhood of the surface, along which cracks rust formations occurred; these large sections had a very characteristic appearance owing to the fine brown veins which were sharply marked off from the other, perfectly fresh nickel-iron. Here again it was noted that iron chloride in meteorites accumulates in those places where the structure is least compact, and that when such places are present it is usually confined to them. The softness of this iron has already been noted by Troost, Blake, and Brezina.

Besides the two pieces of the Blake iron just mentioned, Cohen[29] had the Troost iron once more investigated by J. Fahrenhorst, in order to be able to compare analyses by one hand and by new and better methods. The results were as follows:

	1.	2.	3.	4.	5.	6.
Fe	88.41	88.23	81.45	88.22	88.22	81.11
Ni	11.09	11.01	17.30	11.07	11.01	17.11
Co	0.66	0.72	1.67	0.66	0.72	1.65
Cu	indet.	indet.	0.03	.....	.....	0.03
Cr	0.02	0.02	0.03	0.02	0.02	0.03
C	0.03	0.03	0.07	0.03	0.03	0.07
Cl	0.02	0.01	indet.	.....	.....	.....
S	trace	trace	0.01	.....	.....	.....
P	trace	trace	0.12	.....	.....	.....
	100.23	100.02	100.68	100.00	100.00	100.00

1.—Blake iron (Green County, 1876), from the end of the block with a large section surface.

2.—Blake iron, from the end of the block with a small section surface.

3.—Troost iron (Babbs Mill, 1842).

4 to 6.—The three analyses reckoned to 100, disregarding the sulphur, after abstraction of lawrencite (in the Blake iron) and schreibersite (in the Troost iron).

The analysis of the Troost iron thus corresponds very well with the two former analyses by Clark and Cohen. That this is not the case with that of the Blake iron specimens may be due to the fact that in the first, by Cohen and Weinschenk, less trustworthy methods of separation were employed.

The difference between the chemical composition of the Troost iron and Blake iron specimens is, according to the above results, so noticeable as to occasion doubt whether both masses really belong to the same fall or not. On the other hand, it seems hardly probable that so unusual a phenomenon as the occurrence of ataxites rich in nickel should have happened twice in a narrowly bounded space, and, moreover, two ataxites which are structurally absolutely alike. Also, in respect to chemical composition, a noteworthy chromium content is in both masses combined with the total or almost complete absence of sulphur, a phenomenon which has hitherto been noted only in the Cape iron. Cohen[29] inclines to the supposition, therefore, that both masses belong to the same fall.

The mass of 1876, or Blake iron, is chiefly preserved in the Vienna Museum; the Troost iron is more or less distributed.

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BACUBIRITO.

Sinaloa, Mexico.
Here also Ranchito.
Latitude, 26° 1′ N.; longitude, 108° 3′ W.
Iron. Finest octahedride (Off) of Brezina.
Found 1863; mentioned 1876.
Estimated weight, 27 tons.

The first mention of this mass was by Señor Mariano Barcena,[1] a Mexican scientist and astronomer, in an article devoted to Mexican meteorites. He spoke of it simply as "an enormous meteoric mass lately discovered in the state of Sinaloa." He stated that he could not remember its exact dimensions but could assure the Academy that its length was more than 12 feet. The mass is also mentioned by Castillo in his catalogue of Mexican meteorites.[3] But no one who mentioned it claimed to have seen it and there was no definite description of the mass until a personal investigation was made by Prof. Henry A. Ward[9] in the spring of 1902.

He found the meteorite 7 miles due south from Bacubirito, a small but very old mining town, situated on the Rio Sinaloa in latitude 26° N., longitude 107° W., at an elevation of 2,000 feet above sea level. It was near a little hamlet called Palmar de la Sepulveda. It was found on a farm called Ranchito, which fills the narrow mountain valley or interval between two spurs of the foothills, running nearly north and south. It lay in a corn field, close by the eastern edge of this vale, where the level ground began to rise against the hillside. The valley and the field were of black vegetable soil, some two yards in thickness. In this soil the meteorite lay imbedded, its surface being but little below the general level of the field around it, but one end projecting slightly above the ground. The other end was deeply imbedded in the soil, which had never apparently been disturbed.

On digging away the soil the meteorite was found to lie in a depression crushed into the rock with absolutely no trace of soil between it and the part where the full weight of the mass had fallen and lain. It would thus seem, according to Ward, that the meteorite had fallen on the bare surface of the district at a period before the vegetable soil had begun to form. On the other hand the mass appeared to be well preserved. It showed little oxidation, and the pittings were clean and sharp-rimmed, thus seeming to point to a rather recent fall.

The form suggested a ramus of the lower jaw of a mammal, but was quite irregular. The extreme dimensions of the mass as given by Ward are: Length, 13 feet 1 inch; width, 6 feet 2 inches; thickness, 5 feet 4 inches. Owing to the irregularity of form the cubic contents could be only roughly estimated. Ward estimates the weight at 50 tons, and regards it as the largest meteoric mass in the world.

In structure, according to Ward, the mass exhibits well-defined octahedral crystallization. Fractured surfaces show crystallization plates with faces from 3 to 19 mm. in greatest diameter. Many of these are covered with fine films of tænite, mostly of the characteristic bronze-yellow color. Well-defined Widmannstätten figures of fine pattern are brought out by etching. The kamacite plates are but a fraction of a millimeter in diameter. Some of these blades appear to be of double that thickness, but the glass shows these to consist of several single blades. There is thus a strong development of plessite. The rhombic figures on the etched face average from

1.5 to 5 mm. in diameter, the two angles being 60° and 120°, while the triangular markings range from 8 to 15 mm., with angles of 55°, 55°, and 70°. Troilite nodules are rare The iron is tough, but not more dense than in the majority of siderites. In fact its specific gravity is rather low on account of numerous clefts which permeate it.

Brezina [7] describes a section in the Vienna museum received from Castillo as showing lamellæ 0.05 mm. in width, somewhat cracked, fibrous, and appearing to consist only of tænite. Meshes prominent, plessite dark and full of tænite points. A cut of the section shows curved lamellæ.

Angermann [11] states the meteorite lies in a north and south valley and that the rocks of the region are of eruptive origin, belonging to the group of andesites. He further states that the mass was first discovered in 1863 by being struck by a plough. The brilliant surface of the scratches led the people living near to think it might be silver, but a local blacksmith assured them from the character of the rust that it was iron. The priest at Bacubirito informed the people that the mass had come from hell, and advised them not to disturb it. This advice was heeded, and hence no word of it reached the outside world until the mention of it by Barcena in 1876.

Measurements of the mass are given by Angermann and compared with those of Ward and Castillo as follows:

	Ward.	Castillo.	Angermann.
Length	3.99 m.	3.65 m.	3.50 m.
Breadth	1.9 m.	2.00 m.	2.20 m.
Thickness	1.6 m.	1.50 m.	1.20 m.

From a specific gravity of 7.69 Angermann calculates the weight as 25 metric tons=27.6 tons avoirdupois. The fissure in the meteorite Angermann regards as produced by the shock of striking the earth, and thinks that pieces broken off at the time may be found in the vicinity.

As Whitfield's analysis of this iron showed a loss of 4 per cent, Cohen obtained from Ward material for conducting a new investigation, besides a specimen of some 85 grams weight having a section surface of 14 sq. cm.

This he describes [10] as forming a section 1 cm. thick with an octahedral boundary in conformity with which it was very easy to break off fragments, as there were many cracks visible conforming to the above octahedrons. Upon the polished and etched surface the twinned lamellæ appeared in thin, ragged edged blades, which are of varying width and as much as 1 cm. in length.

Cohen goes on to say:

> Ranchito consists conspicuously of a fine-grained, dark plessite, with small, shining, evenly distributed scales, which are mainly tænite skeletons. The fine lamellæ, about 0.05 mm. wide, intersect at an angle of 60° upon the section. They seldom lie isolated, but group themselvess as a rule in bundles, which attain a breadth of 0.5 mm., but mostly are much finer. From the macroscopic appearance the lamellæ might be supposed to consist of tænite; under the microscope, however, they are distinctly perceived to be built up of extremely fine-grained kamacite and a tænite envelope. The bundles of lamellæ are quite uniformly distributed, and occasionally so long that they reach clear across the section, while the remainder lie isolated in the plessite. Nevertheless, the areas are in general bounded by quite uniform dimensions, from which fact the etched surface acquires a characteristic aspect. On account of the fineness of the tænite leaves and the slight distinction between the kamacites of the bands and fields the lamellæ are faint in luster and color.

Analysis (Whitfield):[9]

Fe	Ni	Co	S	P	Si	
88.944	6.979	0.211	0.005	0.154	trace	=96.293

Specific gravity (Ward), 7.59

Cohen [10] criticised the above analysis on account of the loss of nearly 4 per cent shown, and suggested that a meteorite so rich in tænite ought also to show a higher content of nickel. Later he published an analysis with results as follows:

Fe	Ni	Co	Cu	Cr	C	P	S	Cl	Chromite	
89.54	9.40	0.98	0.02	0.02	0.01	0.12	0.02	0.02	0.01	=100.14

Specific gravity, 7,589.

Ward removed about 11 pounds of the meteorite and distributed it among various collections. The remainder of the mass lies in its original position.

A model of the mass was exhibited by the U. S. National Museum at the Louisiana Purchase Exposition.

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Badger, see Sacramento Mountains.

Baird's Farm, see Asheville.

BALD EAGLE.

Lycoming County, Pennsylvania.
Here also Williamsport.
Latitude 41° 10′ N., longitude 77° 3′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1891; described 1892.
Weight, 3.3 kgs. (7 lbs.).

This iron is described by Ward [2] as having been found about September 25, 1891, by some Italian laborers on the east side of Bald Eagle Mountain, 7 miles south of Williamsport, Pennsylvania. It was covered with a fungous growth, as were the stones under which it was buried to the depth of several feet. Nothing is known as to the time of its fall, although the stones under which it lay buried have not been sensibly moved since the valley of the river on whose banks it was found—the Susquehanna—has been inhabited by white men.

Its weight was 3.3 kgs. (7 pounds 1 ounce).

In form it resembled a human foot, the flat face corresponding to the sole, measuring 16.6 by 8 cm., with a height at the heel of 14 cm. It was very irregular in outline and was covered with many rough notches and depressions, few of which are well-defined pittings. The upper part of the "ankle" only had a well smoothed surface with a fine granulation akin to a "skin" or crust. The surface was covered with a reddish brown iron rust, which scaled off easily and showed the bright metal beneath.

As far as can be learned this is the only specimen of the fall that has been found.

Two cavities were seen on the back above the "heel," one round and three-eighths of an inch in depth and diameter; the other a parallelogram, half as deep and three-fourths of an inch long by one-third of an inch wide, and both having vertical walls—cavities probably produced by the erosion of troilite nodules. On top of the front part of the "foot" was a deep cavity, due to the folds of the iron, which passed nearly through to the sole. The sole was very flat, which permitted the cutting of a slice from it like the "sole" of a shoe. Sharp and peculiar Widmannstätten figures were easily etched on the polished surface with dilute acid, showing a typically octahedral structure. The figures were composed mainly of short kamacite blades, with an average thickness of about 1 mm. and from 5 to 10 mm. in length, which departed from the usual angular figures, being largely curved or snake-like in form and forming a pattern resembling floss or tangled yarn. Many of these kamacite blades were club shaped. The patches of plessite were minute, sometimes showing clearly the alternate layers of kamacite and tænite.

The tænite plates lying between the kamacite blades were very narrow, but stood out in prominent relief on the etched surface, and were fairly distinguishable by their bronze yellow color from the tin-white kamacite.

Two fissures, each about 25 mm. in length and averaging 1 to 2 mm. in width, crossed the "sole" diagonally, and were filled with troilite. No rounded nodules of this mineral were to be seen in the section. Several patches of schreibersite, rudely representing cuneiform characters, were scattered throughout the etched surface. These were brighter and with denser surface than the troilite, the latter being granular and less lustrous.

Ananlysis (Owens):[1]

Fe	Ni	Co	P	S	Si	
91.36	7.56	0.70	0.09	0.06	Trace	=99.77

Specific gravity, 7.06.

The iron is chiefly preserved at Bucknell University.

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Bartlett Meteorite, see Tucson.

Bates County, see Butler.

Batesville, see Joe Wright.

BATH.

Brown County, South Dakota.
Here also Aberdeen, Dakota, 1892.
Latitude, 45° 21′ N.; longitude, 98° 15′ W.
Stone. Brecciated spherical chondrite (Ccb) of Brezina. Type 38, Montrejite; second subtype, Limerickite, of Meunier.
Fell 4 p. m., August 29, 1892; described 1893.
Weight, 21.2 kgs. (46.75 lbs.).

This meteorite was described by Foote [1] as follows:

On the 29th of August, 1892, about 4 o'clock in the afternoon, while Mr. Lawrence Freeman and his son were stacking hay upon his farm about 2 miles south of Bath, they were alarmed by a series of explosions. On looking up they saw a meteoric stone flying through the air followed by a cloud of smoke. Its course was easily traced to the point where it fell, within about 20 rods from where they were standing. The stone penetrated the hardened prairie to a depth of about 16 inches and when reached it was found to be so warm that it had to be handled with gloves. Small pieces of an ounce or two each had apparently been blown off by the explosions, but the stone still weighed 46.75 pounds. One of these small pieces was found by some men not far distant and was broken up and distributed among them. The explosions were plainly heard by a large number of persons at Bath, 2 miles away. At Aberdeen, 9 miles away, the sound was like that of distant cannonading.

The exterior of the stone presents the usual black crust. The interior is described by Foote [1] as quite close grained and containing nickel-iron abundantly disseminated through the mass, in small grains, easily distinguished and separable on pulverizing.

Brezina [3] describes the crust as primary, without marked orientation. He notes an abundance of rounded nickel-iron crystals (cubes) from 2 to 5 mm. in length; and one nickel-iron grain a centimeter in size, with a troilite inclusion. Many faint slipping surfaces, one concave and ribbed like a *Pecten*, are noted by the same author and the chondri are stated to be of two kinds: One yellow, reaching in some cases a diameter of 8 mm., and breaking in two easily; the other smaller, not reaching above 1.5 mm. in diameter, dark and smooth and retaining their form.

This stone is quite generally distributed among collections.

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BATH FURNACE

Bath County, Kentucky.
Latitude 38° 5′ N., longitude 83° 45′ W.
Stone. Intermediate chondrite (Ci), of Brezina.
Fell 6.45 p. m., November 15, 1902; described 1903.
Weight: Three stones, 87.3, 5.7, and .2 kgs. (178, 13, and .5 lbs.).

The first account of this fall was given by Miller,[1] as follows:

On the evening of November 15, at 6.45 central standard time, a very brilliant meteor was observed in its fall to the earth by many persons in the States of Ohio, Kentucky, Tennessee, Louisiana, Mississippi, Alabama, and Georgia. At once, though at first independently of each other, Prof. H. C. Lord, of the Emerson McMillan Observatory, Columbus, Ohio, and the writer began a series of investigations with a view to determining where it should have fallen. We secured reports from some twenty-five or thirty observers scattered over the States mentioned above; none of them, however, were expressed very definitely in terms of angular measurements, excepting those of Professor Lord and myself, and we evidently had not noted the altitude and azimuth of the meteor at exactly the same point of its descent. Satisfied, however, that if any pieces came to earth, they must have fallen somewhere between Lexington and a point in Elliott County, Kentucky, where an observer saw the meteor to the west of him, I was induced to hunt down a rumor that it had fallen in Bath County, and was rewarded by finding that it had indeed come to earth in the extreme southern portion of that county, and had been picked up by the man who saw it strike the ground. The exact point struck was a stone in the road in front of the home of Mr. Buford Staton, 5 miles due south of Salt Lick, Kentucky.

The stone (for it is an aerolite) is roughly 8.5 by 6 by 4 inches, has a volume of 1,642 c. c., and now weighs, with some pieces chipped off for analysis, 5,725 grams, or about 12 pounds 10.5 ounces. It exhibits the usual black crust or varnish, the pittings, the grayish interior, and shows on analysis the disseminated nickeliferous metallic iron.

It is interesting to note that, though the approximate place of this aerolite's fall was not determined by calculations based upon observations giving the azimuths of the point where it appeared to burst, as seen from different stations—the meteorite itself having been brought in before our investigations had reached the calculating stage—yet had it not been seen to strike the earth, it is not improbable that it would have soon been found as a result of special search. A projection of the lines of observation in accordance with the azimuths of the Columbus and Lexington determinations (S. 15° W. and N. 81° E.) cross in the southern portion of Bath County, Kentucky.

Ward[2] gave a further account of the fall and description of the stone found, as follows:

On the evening of November 15, 1902, at about 6.45 o'clock, a brilliant meteor was seen by many persons in the States of Louisiana, Mississippi, Alabama, Georgia, Tennessee, Kentucky, and Ohio, in its progress from southwest to northeast over a course of more than 600 miles. Its passage was simultaneously noticed by two trained observers—Prof. A. H. Miller, of the State College at Lexington, Kentucky, and Prof. H. C. Lord, of the Emerson McMillan Observatory, of Columbus, Ohio. These gentlemen both secured the altitude and azimuth of the point where it appeared to burst and vanish, as seen from their rather widely separated standpoints. Calculations based upon these observations gave the approximative place of the fall, where, indeed, it had already been announced, as in Bath County, Kentucky. The detonations which immediately preceded its descent to the earth were heard over a large area in that region, most persons thinking that they were due to the explosion of nitroglycerin, which is often used in "shooting" wells in the neighboring Ragland oil fields.

The aerolite, for such it was, came to the earth in the extreme southern part of Bath County, at an old settlement called Bath Furnace. It struck in the middle of the road, directly in front of the home of Mr. Buford Staton. Mr. Staton and his wife at once made search for it, but on account of the darkness they failed to find it that night. The next morning, however, Mr. Staton readily discovered the meteorite lying on the surface of the ground on the side of the road, whither it had bounded. It had lost some small chippings by the collision of its fall, but was in the main quite entire.

Mr. Staton, in a letter tells me: "It was dark. I saw the light and heard the report. It came through the air, whizzing like a steam saw going through a plank. * * * The stone struck in the middle of our hard road and bounded away for about 5 feet to one side. The hole which it made in the road was about 1 foot long, 9 inches wide, and 5 inches deep."

The aerolite is in general shape a five-sided polygon, somewhat wedge-shaped when viewed from either the side or the end aspect. Its length is 8.25 inches, height 6.5 inches, width 4.75 inches. The weight of the mass is 12 pounds 13.5 ounces. The clippings broken off in the fall, if added, would doubtless make a total weight of just 13 pounds. Its specific gravity is 3.48.

The stone is covered over its entire surface with a very dark, nearly black, crust. This crust, although absolutely opaque and protective, shows itself at the few fractured spots to be very thin, less than a half millimeter thick. It is dull and matte in surface appearance, with a uniform, fine granulation. This is, however, broken at frequent points by minute pimples, interspersed with equally minute angular or slightly lengthened protuberances. None of all of these have an elevation of more than 1 mm. These pimples, where they have been rubbed, show a bright character, and are undoubtedly outside individuals of the minute points of bright iron which are sprinkled somewhat abundantly through the entire stone mass.

The inner structure of the stone, as shown in a section, is quite compact and dense, taking a good polish. It is a light gray base, blotched evenly throughout with patches of clove-brown iron oxide. Most of these are cloudlike in indefinite contour; but a few, ranging from 1 to 3 mm. in diameter, are round, and seem to be limited to the decomposition of a single previous iron inclosure. Very few defined chondri are detachable.

The whole mass is sprinkled liberally throughout with bright iron particles. Most of these are distributed as a bright star constellation; but among them are scattered a small number which are from 1 to 4 mm. in diameter, mostly of irregular, angular shape. In several instances these are broken sharply in two and are crossed by granular troilite, fine-grained and fresh shining. One of these is a 6 mm. triangle in which the three points only are of bright nickel iron, while the balance is troilite. In two other cases, nodules 2 mm. in diameter have a center of troilite, with a circumference of bright iron. That the brown blotches before referred to are due to the oxidation of iron can not be doubted; but as there has been no opportunity for this process to have gone on, either since the fall of the stone or during its passage through our atmosphere, the question is raised as to its having found the oxygen in the parent body from whence it came?

Piezographs, or finger-mark pittings, are visible on all surfaces of the mass, yet varying notably on different sides. On two sides they are few in number, and only dim depressions, though still unmistakable in their nature. On the other three surfaces they are frequent, and are 3 to 5 mm. in depth, with area as large as the end of an adult human finger. Some few are independently placed, but most of them are confluent, and show the line of movement of the mass through the furrowing air. One notable gathering is curiously like the crowded tracks of three or four kittens' feet. Two of the smaller sides of the mass have a very different pitting, that thickly crowded raindrop appearance which is often found on a secondary crust which has formed on a fresh surface after the breaking of the mass in the air. In one place there is a furrow 1.5 inches long and 2 to 4 mm. deep and wide, with walls of overhanging crust. So far as examination has yet been carried, this new aerolite presents no features of form or of composition which are materially different from others of its class. A careful petrographical examination may, however, reveal something of especial moment. The relation of the intruding troilite to the riven particles of nickel iron certainly merits further investigation.

At my request, Professor Merrill, of the National Museum, has kindly made a couple of slides of the mass, and reports as follows: "The stone consists essentially of olivine and pyroxene, with the usual metallic sprinklings and troilite. There is present also in small quantities a completely colorless, almost isotropic mineral, which is probably maskelynite, although if such is the case, it is a product of original crystallization and has not been altered by fusion, as suggested by Tschermak. The mineral is in too small quantities to be determined accurately from the two sections which I have thus far prepared. The stone is chondritic, but the chondrules show no disposition to separate from the ground mass, and I am inclined to classify it with Brezina's intermediate chondrites (Ci)."

Miller [3] gave a later account of the fall as follows:

Since the announcement concerning Bath Furnace Aerolite No. 1, which appeared in *Science* of January 16, two other pieces have been found; one picked up within 100 yards of where No. 1 fell and the other one three-fourths of a mile south of this. Named in the order in which they were found, we have designated these as No. 2 and No. 3, respectively.

No. 2 weighed 223 grams. It was completely coated with the black enamel or varnish, and pitted. It has been sawed into two pieces, one for the Field Columbian Museum and the other for the Kentucky State College Museum. It has the same specific gravity and presents the same interior appearance as Bath Furnace No. 1.

No. 3, found about the middle of May last by a hunter who was led to search for it by noticing a skinned place some distance up on a white-oak sapling, will weigh about 200 pounds. It is also completely coated with the black enamel and is very characteristically pitted and furrowed. These furrows radiate from a smooth nose or boss. It was this portion which bruised its way downward into the base and roots of the tree. The side opposite to this is flat and not furrowed nor pitted, but presents a few nodular excrescences.

As a result of visiting the locality, examining the places where the pieces struck, and securing the accounts of the residents, all of whom were much startled by the blinding light and terrific detonations accompanying the fall, I gather the following: There was probably one mass originally, which burst at a height of from 8 to 9 miles into many fragments. These fragments struck the earth in a district some 4 miles square, situated in the knobs of the extreme southern portion of Bath County. Most of the region is thinly populated. No. 3 was found almost in the center of this thinly populated district. The accounts given by the residents of the noise made by the "explosion," of the singing of the fragments as they hurtled through the air, and the sound made by their striking the ground or hitting the timber on the knobs were very graphic.

No. 3, which is probably the main portion of the original mass, has left some record from which possibly the trajectory of this celestial body may be computed. From the way in which it grazed the sapling in its descent and bruised its way into the roots of the tree at the base of which it was found, I estimate that it came in from a direction 13° south of west and at an angle from the horizontal of 77°. As previously announced, the altitude of the point of the bursting of the meteor, as seen from Lexington, was 9° 30′. The azimuth of this point is N. 81° E. The point of fall, however, plots out on the map almost due east of Lexington and distant 51 miles.

Two other saplings in the vicinity of where No. 3 fell, distant, respectively, about 100 and 200 yards in an easterly direction, have been broken off by missiles striking them from the west. Search for where these buried themselves in the ground was not rewarded with success.

The dent in the road made by No. 1 had become obliterated, but from the accounts of those who saw it soon after it was made it dipped eastward, and so is in line with the evidence afforded by the other fragments.

Ward [4] gave a résumé of the previous history of the meteorite and described as follows the largest stone:

The third piece was found near the middle of May, 1903, about 1.75 miles south of the other two pieces, by a squirrel hunter, Jack Pegrim, whose attention was drawn to a scar on a white-oak tree, some 15 feet from the ground. Looking around he found, a few yards farther on at the foot of a larger tree, broken roots and a hole beneath. Searching here, he found the great aerolite buried less than 2 feet, its apex crowded in among the roots, some of which had been cut through by the impact. Two other saplings in this vicinity, respectively about 100 and 300 yards farther east, were broken off by missiles coming from the west, and it is therefore probable that there were several other pieces besides the three here recorded, although search for them has been unsuccessful. * * * All three of the original masses of this aerolite are quite covered with a dense, black crust which is of two degrees, primary and secondary. The primary crust covers the entire surface of mass No 1, two sides of No. 2, and all but one of the sides of No. 3, with the exception of the parts where, as mentioned, pieces have chipped off. These last faces or scars have, indeed, a crust quite covering them, but it is much thinner than the other, and through it appears the texture of the broken surface beneath. These areas of secondary crust attest to a breaking of the stone in the air while it yet had great velocity and while it had still so great distance to fall that there was time for a second crust to form. * * *

The base of mass No. 3, the largest single surface, has the usual thick crust which characterizes the rear of all well-oriented aerolites. It has been protected from the pitting and furrowing effect of the rushing air, while all the results of melting have remained, not being swept away. On the opposite point or prominence of the front there is (as is usual on this form of aerolites) a very thin crust and bare of all pittings.

This third mass of the Bath Furnace is one of the most completely furrowed and definitely oriented aerolites known to science. We know no stone of American fall which equals it in this respect. The furrowing of the front side is most complete. These furrows radiate from the apex in all directions, covering that surface and streaming back upon and over all the sides.

Farrington [5] gave a further account of the small stone as follows:

Of the three known stones of this fall, one-half the smallest one, weighing 223 grams, came into the possession of the Field Museum. This individual is of irregular disklike form, of 2½ by 1½ by ¾ inches dimension. Though its shape indicates that it was a scaling, it was completely incrusted and shows orientation. One of the broad surfaces was plainly the front side, the opposite the rear side. The front side shows lines of flow radiating from an eccentric point. These lines have under the lens the form of ridges of inverted V-shape, gradually branching and tapering out. These ridges are of shining black glass and rise above a dull-black ground. The interior substance of the meteorite is gray, with rusted spots about the metallic grains. It is of sufficiently firm texture to take a good polish. Under the microscope the crust is seen to be relatively thin, .2 to .3 mm. The zones of Tschermak are indicated, but are by no means well marked. For the most part the crust appears as a black, opaque aggregate bordering the edge of the section, with here and there transparent grains of various sizes seen in polarized light to be unaltered olivine. The remainder of the section appears in ordinary light a confused mass of transparent grains considerably iron stained and interspersed with metallic grains of very irregular but usually elongated shapes. Among these troilite is more numerous than nickel iron. An opaque, black substance also occurs in small quantity connected here and there with the metallic grains. It may be of ferrous or carbonaceous nature. Chondri are but occasionally and imperfectly outlined. In polarized light the chondri can be more readily recognized. They are not numerous, however, the greater part of the section being made up of anhedral grains of various sizes. Chondri where visible are for the most part sharply outlined from the surrounding mass. Those composed of alternate lamellæ of olivine and glass are the most common, and next in number are those composed chiefly of fibrous enstatite. Large chondri composed of porphyritic anhedral olivines or of olivine and enstatite also occur. These olivines frequently reach a length of .2 to .3 mm. and have well-defined prismatic outlines. The interstices between the crystals are usually filled with a turbid glass. The outlines of these chondri as a rule are less marked than are those composed of olivine and glass. Most of the chondri have spheroidal outlines, though a few fragmental forms occur. Among the constituents of the general mass, lath-shaped crystals of enstatite .3 to .5 mm. in length, with cleavage parallel to the direction of length, are the most conspicuous. These and the enstatite chondri are sufficiently numerous to indicate a large proportion of this mineral in the constitution of the mass. Besides enstatite, grains of olivine of various sizes and outlines are to be seen in considerable quantity.

The meteorite in falling grazed a tree, leaving a scar the observation of which by a squirrel hunter led to the discovery of the mass. Erection of a pole connecting the scar and the place of fall of the meteorite seemed to the writer to indicate a nearly vertical direction of fall. Miller, however, estimated the angle to be 77° with the horizon, or 13° from vertical. The large roots of the tree prevented the stone from going deeply into the soil, and it was found resting on them. Considering the weight of the mass and the distance of its fall it is remarkable that it was not shattered by the impact and that the roots on which it fell were not more deeply bruised.

The large stone, and most of the 13-pound mass, are now in the Ward-Coonley collection.

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Battle River, see Victoria.

BEAR CREEK.

Jefferson County, Colorado.
Here also Aeriotopos, Bear River, Colorado, Denver County, and Jefferson.
Latitude, 39° 48′ N., longitude, 105° 5′ W.
Iron. Fine octahedrite (Of) of Brezina; Caillite (type 18) of Meunier.
Found, 1866; described, 1866.
Weight (estimated), 227 kgs. (500 lbs.).

The first account of this meteorite was by Shepard [1] under the title of "Colorado" and was as follows:

If neither of the two preceding irons are likely to be represented in our collections there is certainly a prospect that it will be quite otherwise with the mass just discovered upon the eastern slope of the Sierra Madre Range of the Rocky Mountains.

For my acquaintance with this discovery I am indebted to the kindness of Mr. J. Alden Smith, a practical mineralogist, at present residing in Colorado. This gentleman has transmitted to me by mail a very interesting cleavage lamina, 1.5 inches long by three-fifths of an inch wide and one-eighth thick, and which shows on one edge a portion of the natural coating of the meteorite. His letter, dated June 21st, is very brief, though it contains important particulars which I can not withhold from the scientific public until his return to the East in the coming autumn. By means of the promised specimens he expects to bring with him on his return, I hope to be able to give a more circumstantial account of the discovery.

The detection of the mass, and which has occurred only within a few weeks, is due to Messrs. Wilson and Morrison, by whom Mr. Smith was shown to the locality. It is situated within a very deep ravine, at the elevation of 8,000 feet above the ocean and surrounded with high mountains on all sides. The exact dimensions of the mass are not given; but its weight is supposed to be several hundred pounds. "It seems to have struck a crevice in the solid ledge, and thereby to have been much shattered at one extremity—a circumstance that enabled the finders to detach several small pieces." They inferred the fall to have taken place at a very remote period, as the mass exhibited a coating of oxyds half an inch thick. "Its composition is principally the native metals, iron, nickel, cobalt, a little manganese, and a trace of copper. In some parts, iron forms the chief ingredient, while in others nickel and cobalt are largely in excess."

The specimen in my possession exceeds every iron I have seen in the perfection of its crystallization. It is as coarsely crystalline as that of Arva (Hungary) or Cocke County (Tennessee), but much more intimately laminated with schreibersite than either. The laminæ of this substance are unusually thick and possess a light color together with a bright luster. As they are disposed in accordance with the octahedral cleavage of the iron they render the Widmanstättian figures strikingly apparent without polishing or the use of acids. No pyrites or graphite is visible in my specimen. Specific gravity=7.43.

Further details were given by Henry [2] the same year in the American Journal of Science, as follows:

Professor Henry has transmitted to the editors a note respecting the discovery of a mass of iron in a deep gulch near Bear Creek, Colorado Territory, about 25 or 30 miles from Denver, and 800 or 1,000 feet below the top of a steep hill. Mr. James L. Wilson, who describes it in the Daily News published at Denver, Colorado Territory, May 14th, states that it was at first mistaken by himself and Mr. G. R. Morrison, who accompanied him, and who had seen it before, for the "blossom" or "iron hat" of a mineral lode. "It is irregular in form, being about 22 inches long, 9 to 10 broad, and 14 wide. Four of its faces are flat and two rounded. This form indicates it to be a fragment of a much larger mass. It is magnetic. Its weight is estimated at 500 pounds. The force with which it struck the rocks at the time of its fall had so shattered one end as to enable the discoverers to break off a piece that weighed about 11 pounds. Its composition appears to be iron, nickel, cobalt, and copper, unequally distributed in its mass. In one part the nickel and cobalt are largely in excess of the other metals, while in other parts iron forms the chief ingredient. These metals are aggregated and highly crystallized. A coating of the oxyd of iron half an inch thick has taken the place of the shining black crust observed on aerolites when they first reach the earth. The less oxydizable metals, nickel and cobalt, still remain in their metallic state in this coating of iron rust."

It is pretty certain from this not satisfactory description, that this is an example of an iron meteor-mass found where it has fallen, the shattering of the mass and of the adjacent rocks being rarely observed. It was exposed by a

freshet which had washed away the loose stones and earth. This is the same mass noticed by Professor Shepard at page 250 of this issue, who appears to have been in possession of some scales from the concussion which disintegrated the specimen. We have taken steps to obtain more detailed information respecting it.

The next year Smith [3] published an analysis of the meteorite as follows:

The first of these irons (Russel Gulch) I described in the September number of this journal, calling it the "Colorado meteorite." Owing to the discovery of another in the same territory (specimens of which have been in my possession for some little time), it will be proper to designate the first mass as the "Russel Gulch" iron and the other as the "Bear Creek" iron. Of this last there are two short notices in the November number of this journal. The specimen of it in my possession has enabled me to make a thorough examination of the constituents. The piece I have has a portion of the exterior attached.

As has already been stated by Professor Shepard, it is coarsely crystalline and laminated from the effects of decomposition between the crystals; the surface contains considerable pyrites, although Professor Shepard did not discover any in his specimen. I was enabled to separate and analyze magnetic pyrites, schreibersite, and nickeliferous iron. Of the magnetic pyrites sufficient was separated to make a quantitative determination, which was as follows:

Sulphur	35.08
Iron	61.82
Nickel	.41
Insoluble residue	1.81
	99.12

The schreibersite was not obtained in sufficient quantity for a complete analysis; about 50 milligrams of the pure mineral gave all the constituents usually found in this interesting mineral.

The nickeliferous iron, constituting of course the great bulk of the mass, was composed as follows:

Iron	83.89
Nickel	14.06
Cobalt	.83
Copper	minute quantity
Phosphorus	.21
	98.99

The laminæ of iron are often very brilliant, having the luster of silver, and caused me to suspect more nickel than was found. It was supposed that in the decomposition of the crystals the iron would disappear more rapidly than the nickel, and that by a process of cementation the nickel would accumulate in the laminæ; but from careful examination of the process of decomposition there is no doubt that the interior of the mass will not differ materially in its composition from the analysis already given of the nickeliferous iron. Besides the minerals already mentioned, and which properly belong to the original mass, there is much oxyd of iron containing some nickel arising from the decomposition of the surface.

Shortly after, Jackson [4] also published an analysis, as follows:

I received last Tuesday, November 6, a piece of meteoric iron from Rev. Mr. Thompson, who brought it from Colorado, and who had negotiated for the large mass with the intention of presenting it to the Boston Society of Natural History. I have just learned that Professor Shepard, through the agency of a friend in Denver City, has secured the original mass, said to be 2 feet in diameter, for his cabinet. It appears, from Professor Shepard's letter to me, that it is the same mass that is mentioned in the last (September) number of your journal, page 250. I made the chemical analysis of it before being aware it was the same meteorite described, and since no previous analysis of it has been made I offer mine to you for the journal, Professor Shepard expressing a desire that it should be published.

The piece of meteoric iron given me by Mr. Thompson, who brought it from Colorado, weighs 4 ounces. It has been heated in a forge fire in order to cut it more easily; but still the Widmanstättian figures come out when dilute nitric acid is applied to the polished surface, as distinctly as possible, and consist of a series of small, nearly equilateral triangles with the lines well defined and quite elevated. On one side of the specimen was a crust about one-eighth of an inch thick, consisting of sulphid of iron. This probably, in the unaltered meteorite, is a bisulphid of iron mixed with oxyd of iron.

A portion of the clean metal sawed off from the mass has a specific gravity of 7.692.

On chemical analysis by the most approved method, separating the iron from the nickel by succinate of ammonia and determing the nickel as oxyd of nickel, and then analyzing this oxyd for cobalt and copper—a separate portion of the meteorite being employed in analysis for the tin, which was twice determined, and the nitric solution being tested for phosphoric acid and sulphuric acid, etc.—the results of my analysis in per cent are as follows:

Metallic iron	90.650
Metallic nickel	7.867
Metallic cobalt	.010
Metallic tin	.020
Insoluble matter consisting of a little silica, schreibersite, and chrome, as proved by blowpipe investigation	.950
	99.497

Brezina [5] classed the meteorite as an octahedrite with fine lamellæ in the Hraschina group. He gives the breadth of the bands as 0.5 mm. and notes that the plessite is bright.

Meunier [6] grouped the meteorite as Caillite, and described its structure as follows:

The figure given by the iron of Bear Creek is finer than that of the iron of Caille, and in some characters it departs a little from the type without being altogether distinguishable. The kamacite, in little bands alternating with the lamellæ of tænite, forms compact groups, at times thick, which surround places occupied, now by plessite associated with tænite, and now by pyrrhotine enveloped by an extremely thin layer of graphite. Schreibersite occurs in scales at times quite abundant.

Leick [7] noted a parting in the troilite of Bear Creek, which indicated that it crystallized in the isometric system. The planes which he recognized by goniometric measurement were those of the cube and dodecahedron. Later, however, he [10] concluded that these measurements were not trustworthy. He found [8] the troilite of the meteorite a good conductor of electricity.

Preston [9] gave the following note regarding the locality of the meteorite:

Bear Creek has been noted in most catalogues as having been found in Denver *County*, Colorado, which is a mistake, as Colorado has no county by this name. It was first mentioned by Shepard as found upon the eastern slope of the Sierre Madre Range of the Rocky Mountains. Again Henry notes it as found in a deep gulch near Bear Creek, about 25 or 30 miles from Denver. Smith in describing this meteorite gave it the name of Bear Creek. As Denver is on the boundary line between Arapahoe and Jefferson Counties, and as there is a Bear Creek extending clear across Jefferson County from west to east, emptying into the Platte, according to Henry's description, this would bring the locality of the Bear Creek meteorite in the western central part of Jefferson County. Therefore, it seems likely that the iron noted in the Shepard collection as "Jefferson, 30 miles from Denver," is in reality a portion of the Bear Creek meteorite labelled "Jefferson" meaning Jefferson County, and that the date of fall, June, 1867, is an error. Particularly so as the Bear Creek is described by Henry as being "shattered at one end," so that small pieces could be readily detached.

Denver County has evidently been substituted for Denver city in many of the meteorite lists, as no county is given in any of the early reports of the Bear Creek meteorite. Moreover, the Sierre Madre Range is west of Denver, and Bear Creek is described as having been found on its *eastern slope*, which, in all probability, would bring it in Jefferson County. So it would seem best that "Jefferson" should be discarded entirely as a distinct fall and be called Bear Creek, and that Denver County in all meteorite lists should read Denver city.

Cohen [11] described the structure of the meteorite as follows:

The lamellæ are long, straight, swollen, seldom grouped, and consist of strongly hatched granular kamacite, with very fine etching pits and well-developed tænite. Since the hatching lines penetrate without hindrance the forks between the granules, the latter are separation phenomena and do not indicate a granular structure of the kamacite. The fields are uniformly distributed and vary little in their size. They are strongly developed, although somewhat subordinate to the bands. The gray, rather bright plessite consists, as a rule, of grains whose size averages 0.03 mm., and varies between boundaries of 0.02 and 0.10 mm. On strong magnification grains appear in it surrounded by delicate tænite-like borders and separated by fine veins distinguished by lack of luster and by a dark color from the nickel-iron of the grains. Since it is remarkably depressed it is perhaps a nickel-free or nickel-poor iron. At the edge of the fields the grains go over into short, compressed bands. Plessite of this character was described by Tschermak from Ilimæ. Tænite ramifies into many fields and the kamacite grains often lie isolated in the tænite groundmass which is sharply distinguished by its smooth surface, luster, and light yellow color, and seems to be an outgrowth of the tænite surrounding the bands. Again, in other fields, the dull, depressed black veins extend, producing a very fine-grained or striated structure, and form a groundmass in which are imbedded isolated kamacite grains. Finally, some fields show combs which, in consequence of their unusual breadth, are plainly outgrowths of the bands. Rarely does the intimate structure of plessite exhibit itself so clearly. Schreibersite is very richly present. In part it forms large crystals up to 15 mm. in length, occasionally showing hieroglyphic forms; in part there are smaller individuals which either lie in the bands, producing a lumpy shape, or are surrounded by typical swathing kamacite. At times one can plainly see that the latter is a deformed lamella, since one such lamella of normal development widens at the end to a ring which incloses a grain of schreibersite. In addition, small shining grains and short rods occur in many bands which likewise appear to be schreibersite but could also be cohenite. Large troilite nodules surrounded by swathing kamacite show a peculiar angular-granular appearance and a lamellar structure of each grain gives a resemblance to the so-called coral ore.

The meteorite is chiefly preserved (436 pounds) in the Amherst collection.

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BEAVER CREEK.

West Kootenai district, British Columbia.
Latitude, 51° 10′ N.; longitude, 117° 30′ W.
Stone. Crystalline spherical chondrite (Cck) of Brezina; Sigenite (type 35) of Meunier.
Fell between 3 and 4 p. m., May 26, 1893; described 1893.
Weight, 14 kgs. (31 lbs.)

A detailed description of this meteorite was given by Howell,[3] Hillebrand,[4] and Merrill[5] as follows:

In the number of "Science" dated July 21, 1893, I (Howell) gave a brief history of this meteorite as then known, and proposed the above name from the stream near which it fell.

The accompanying cut gives a fair idea of the stone as first seen by me. It measured 6 by 7 by 9.5 inches and weighed 22.5 pounds. About 3 or 4 pounds had been broken from the bottom as shown in the cut. The original weight must have been approximately 26 pounds and the length 12 inches.

After repeated efforts and much correspondence I have been unable to secure any more of the fall. The reports at first stated that two smaller pieces of a few pounds each were seen to fall. This, however, seems to have been a mistake, as only one other piece of 4 or 5 pounds, so far as I can learn, was seen. A portion at least of this smaller piece was broken into fragments and distributed the same as the most of that which was broken from the larger mass before it came into my possession, July 6, 1893, by purchase from Mr. James Hislop, a civil engineer, who found and dug it up the morning after it fell and brought it to Washington. It buried itself in the earth about 3 feet—2 feet in soil and 1 foot in hardpan.

The direction of the hole was south 60° east, true meridian, and at an angle of 58° with the horizon. Fresh earth was scattered about the hole in all directions, but farthest (10 feet) in the direction from which the stone came.

It fell between the hours of 3 and 4 p. m. May 26, 1893, near Beaver Creek, West Kootenai district, British Columbia, a few miles north of the United States boundary and about 10 miles above where the creek joins the Columbia River.

The report was heard by persons within a radius of nearly 25 miles, and it was believed by many who heard it that larger pieces must have fallen than those secured. The stone is a typical aerolite of very pronounced chondritic structure, has the usual fused black crust, but has one feature unlike any other meteorite with which I am familiar. Beneath the crust there is a slight oxidation for a distance of from one-half to three-quarters of an inch which seemingly must have occurred before it struck the earth, and for which thus far no satisfactory explanation is suggested.

There is no occasion to further describe the character of this stone as that part will be found fully discussed in the accompanying paper by Doctors Hillebrand, of the U. S. Geological Survey, and Merrill, of the U. S. National Museum.

CHEMICAL DISCUSSION BY DR. W. F. HILLEBRAND.

The material received for chemical examination was in a crushed state, much of it in fine powder, being the waste resulting from cutting the rocky mass. There was scattered throughout it some organic matter derived from a burnishing brush, which, though insignificant as regards weight, rendered useless any attempt to look for organic matter proper to the meteorite itself.

Of this mass, 26.1892 grams, after repeated separation under alcohol by an electro-magnet, yielded 5.0710 grams of magnetic material which still contained over 10 per cent of unmagnetic substance, as shown by the following analysis:

Analysis of magnetic material.

Fe	80.21	88.456
Ni	7.78	
Co	.44	
Cu	.026	
Silicates	5.17	
SiO_2	1.31	
MgO	1.31	
FeO	1.20	
Fe_3O_4	.83	
FeS	.77	
P_2O_5	.057	
Al_2O_3, CaO, Alk., and loss by diff	.897	
	100.000	

The metallic part therefore comprises 17.13 per cent of the meteorite and is composed as follows:

Fe	90.68
Ni	8.80
Co	.49
Cu	.03
	100.00

By the procedure outlined in one of the footnotes to the foregoing analysis the isolation of the magnetite from all but a very small proportion of siliceous matter is easy. It then appears under the microscope as irregular grains of a dull-black, lusterless surface. Only one grain presented an apparently octahedral aspect.

The main portion of the meteorite material, now freed from all magnetic matter, was thoroughly mixed and pulverized. Its composition follows:

Analysis of unmagnetic material.

S	2.21	6.08 troilite.
Fe	3.87	
FeO	.24	.75 chromite.
Cr_2O_3	.51	
SiO_2	45.87	
TiO_2	.09	
Al_2O_3	2.30	
FeO	12.44	
NiO	.07	
MnO	.26	(too low).
CaO	1.96	
MgO	28.24	
K_2O	.15	
Na_2O	.98	
Li_2O	None.	
H_2O above 100° C	.34	
P_2O_5	.30	
Cl	Trace.	
	99.83	

The assumption of FeO as the sole divalent element in the chromite is entirely arbitrary. Qualitative tests on a minute quantity separated from the silicates showed that the mineral carried magnesia and alumina also. The extremely weak magnetism of the troilite appears clearly from the fact that the electromagnet produced only a barely perceptible concentration of it in the magnetic mixture, as shown by comparing the percentages of troilite and of silicates therein with those just above.

A portion of the unmagnetic powder was then divided into a soluble and an insoluble part by digesting for a few hours with dilute hydrochloric acid on the water bath, filtering, separating gelatinized silica by dilute solution of potassium hydroxide, and repeating the treatment of the residue with acid and alkali. In this way there was decomposed 51.11 per cent of the whole. The composition of both soluble and insoluble parts as actually found by analysis is as follows, the S and P_2O_5 being taken from the previous analysis, as also the water of the soluble part after allowing for the trifle belonging to the insoluble portion.

	Soluble portion.		Insoluble portion.	
S	2.21	6.08 troilite.		
Fe	3.87			
FeO	.01	.04 chromite.	0.23	0.73 chromite.
Cr_2O_3	.03		.50	
SiO_2	17.03		27.74	
TiO_2			.09	
Al_2O_3	.25		2.34	
FeO	8.69		3.85	
NiO	.04		Trace.	
MnO	.12		.17	
CaO	.46		1.65	
MgO	17.24		11.14	
K_2O	.01		.12	
Na_2O	.06		.90	
H_2O above 100° C	.31		.03	
P_2O_5	.30			
Cl	Trace.			
Loss	.48		.13	
	51.11		48.89	

Excluding troilite and chromite, but including phosphate, the percentage composition of the soluble and insoluble mixtures is as follows:

	Soluble portion.	Insoluble portion.
SiO_2	38.26	57.75
TiO_2		.18
Al_2O_3	.56	4.89
FeO	19.52	8.02
NiO	.09	Trace.
MnO	.27	.35
CaO	1.03	3.44
MgO	38.73	23.19
K_2O	.02	.25
Na_2O	.13	1.87
H_2O above 100° C	.70	.06
P_2O_5	.68	
Cl	Trace.	
	99.99	100.00

Whether the titanium belongs to the pyroxene or is to be credited to a special titaniferous mineral, such as ilmenite for instance, the analysis does not show. The siliceous constituents of the stony matter appear from the analysis to be chiefly olivine and the bronzite variety of enstatite. In order to throw further light, if possible, on the character of the mineral or minerals in the soluble part, a portion of the latter was subjected to prolonged treatment with hydrochloric acid followed by dilute potassium hydroxide solution, after which an attempt was made to effect further separation by the Sonnstadt solution with very limited success. The main portion thus finally obtained was analyzed. It gave the following composition:

FeO	0.31	0.96 chromite.
Cr_2O_3	.65	
SiO_2	56.48	
TiO_2	.19	
Al_2O_3	2.65	
FeO	9.14	
NiO		
MnO	.46	
CaO	2.97	
MgO	25.86	
K_2O	.18	
Na_2O	1.20	
H_2O		
	100.09	

Comparison of this with the preceding analysis of the insoluble part of the meteorite shows unquestionably that its siliceous component is a mixture and that the effect of the second acid and subsequent mechanical treatment was to remove partially a relatively soluble alkali-lime-alumina silicate. That this more soluble ingredient is largely of feldspathic nature is, however, negatived by the fact that the last analysis, omitting chromite and titanium, affords almost exactly a metasilicate ratio, and by the failure of Doctor Merrill to identify any feldspathic mineral constituent in more than mere traces.

From the data at hand the composition of the meteorite as a whole resolves itself as follows, assuming for the mixed silicates in the magnetic portion the same composition as that shown by the nonmagnetic mixture:

Nickel-iron	17.13
Magnetite	.16
Troilite (0.15 in magnetic, 4.90 in nonmagnetic part)	5.05
Soluble silicates and phosphate	37.23
Insoluble silicates and chromite	40.43
	100.00

MICROSCOPICAL DISCUSSION BY DR. GEORGE P. MERRILL.

The stone is of a gray color and granular structure, quite fine grained and friable but showing to the unaided eye a finely granular groundmass studded with small spherules or chondri in sizes rarely if ever exceeding 2 mm. in greatest diameter, and averaging not more than half that amount. With the pocket lens it is seen that the groundmass is also largely chondritic, but interspersed with granular material and glistening metallic particles. So far as material is at hand for comparison, the stone macroscopically most resembles that of New Concord, Ohio, but is much more granular and friable, as well as more pronouncedly chondritic. In the thin section under the microscope it presents no feature not common to stones of its class, and various portions of its field show structures in every way similar to those of Mezo-Madras, Homestead, and Dhurmsala, as figured by Tschermak, or that of San Emigdio stone as described by myself. There are the usual monosomatic and polysomatic chondri, sometimes of olivine alone, enstatite alone, or olivine and enstatite together, in granular or porphyritic forms with glassy base, or radiating and barred forms. The olivines not

infrequently occur with interiors made up of small rounded granules imbedded in a glass base, but extinguishing simultaneously with the outer portion. In many respects the microstructure closely simulates that of the San Emigdio stone, but the apparent fragmental nature is less conspicuously marked. In two instances small irregular colorless granules were observed giving faintly the twinning striæ and inclined extinctions characteristic of plagioclase feldspars. It is not possible from the examination of the two slides at command to state more definitely as to the presence or absence of this or of silicate minerals other than those mentioned.

Brezina [6] classified the meteorite as a crystalline chondrite and gave the following observations upon it:

This mass shows an amalgamation of granular and crystalline characteristics; the groundmass is porous and has the shimmering appearance of crystalline chondrites (Ck). The globules, as much as 6 mm. in size, are very abundant, and for the most part remain whole, but some are broken in two and stand out sharply against the groundmass. The color of the stone is quite a deep gray on the fresher portions, verging upon the rust brown of the altered substance toward the outer surface.

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BELLA ROCA.

Durango, Mexico.
Here also La Bella Roca and Papasquiaro.
Latitude 24° 55′ N., longitude 105° 25′ W.
Iron. Fine octahedrite (Of) of Brezina; Rocite (type 14), of Meunier.
Described 1889.
Weight 33 kgs. (72. 6 lbs.).

This meteorite was found on a peak of the Sierra de San Francisco, called La Bella Roca, near Santiago Papasquiaro in the State of Durango, Mexico. The date of its discovery and the name of the finder are unknown. The meteorite was first described by Whitfield,[1] as follows:

The two greatest dimensions of the mass were 24.13 cm. by 34.92 cm.

A feature of the composition of the mass was the presence of large deep pittings on one side; these were a little greater in diameter just below, than immediately at, the surface, and each one had a little substance left on the bottom, which evidently was the remains of what originally filled the cavities. As the analysis shows, this material was troilite (FeS 85.27, Fe 9.37, NiS, 2.13).

The exposed surface of the troilite was greatly decomposed, and gave ground for the idea that the deep pittings were formed by the removal of troilite nodules, partly while the mass was hot and partly by the subsequent weathering. There were nodules of troilite throughout the entire mass of the meteorite, but none were removed so as to form pittings on any other part of the surface but the side which is supposed to have been the front. The mass was deeply furrowed and all the furrows trended away from the side containing the pittings.

Slices of the meteorite, when etched, showed rather coarse Widmannstätten figures and also dark diagonal bands of troilite.

Analysis by Whitfield gave the following result:

Fe	91. 48
Ni	7. 92
Co	0. 22
C	0. 06
P	0. 21
S	0. 21
	100. 10

Whitfield also analyzed the inner and outer portions of a troilite nodule, the results being as follows:

	Inner portion.	Outer portion.
NiS	2. 13	2. 07
FeS	85. 27	37. 51
Fe_2O_3	.....	37. 80
H_2O	.....	19. 85
Fe	9. 37	.....
	96. 77	97. 23

Brezina[6] definitely proved the association of tænite with plessite in this mass.

Meunier[7] describes it as a common type but possessing a very distinct character from the association with nickel-iron of large quantities of troilite which is disseminated quite uniformly throughout the rock, the same sulphide being also present as huge cylindrical forms enveloped in a thick sheath of graphite and schreibersite. The result is a rock which does not conform to any other.

Brezina[8] also describes it as a highly oriented iron with an almost complete fusion crust, and one which can have lain in the open air only a short time prior to its discovery. On the front side of the iron he notes—

a fusion ridge resembling strands of hair parting asunder, while the rear side, 1 to 2 mm. thick, is covered with a granular crust which appears porous in cross section, and sometimes drops measuring 1.5 cm. in diameter are reduced to 0.5 cm. in thickness. The regular arrangement of laminæ and interspaces, the very marked development of tænite and its extraordinary richness in schreibersite crystals make this iron one of the most beautiful and instructive among known meteorites. The broad bordered kamacite bands are almost in equal proportion to the fields filled with shimmering plessite. On one part of the iron the triad is deformed, bent. The large schreibersite laminæ, as much as 5 cm. in length, are abundantly and evenly distributed throughout the entire mass; they are usually embedded in kamacite 1 to 1.5 mm. thick and follow the octahedral laminæ in their orientation. Numerous troilite concretions, measuring 1.5 to 3.5 cm. are found intact on the inside and upon the rear side, but on the front side they are mostly fused out; in numerous places may be seen a tonguelike indentation of the troilite by the trias, which causes the enveloping kamacite to follow the indentation like an intercalary layer. Occasionally, also grains of iron are found inside of the troilite and a tongue of iron or included grains of iron may sometimes be observed inclosed entirely in graphite. It is frequently found, that on the scaly borders of the trias, on the side toward the troilite granules, after the removal of the latter, the laminæ terminate in crystalline boundary surfaces.

Schreibersite occurs in individual crystals, some of which resemble cohenite crystals; it also occurs in plates 1.5 mm. thick by 6 cm. in length and lying parallel to the octahedral facets; in fact, Bella Roca is distinguished by a very unusual richness in schreibersite. The meteorite is also noted for the exceptionally high percentage of iron sulphide it contains and for the large lumps in which it occurs.

Cohen[11] described the structure of the meteorite as follows:

Bella Roca is distinguished by long, straight, strongly swollen, few and weakly grouped lamellæ, unusually well developed tænite bounding uniformly distributed fields which are nearly equal in extent to the bands. The kamacite, which is occasionally somewhat coarse-granular, affords a uniform, dull, peculiar sheen. Under the microscope it shows so fine a granulation that even under the strongest enlargement it can not be determined what produces it. The fields consist almost wholly of opaque, dark plessite. As a rule they are uniformly penetrated by minute, shining scales. In the larger fields though, the shining inclusions are somewhat larger, and appear on strong magnification as closed curves of various shapes 0.01 to 0.02 mm. in diameter surrounding dark grains. One such field is surrounded by a broad, dark edge 0.05 to 0.1 mm. in width, not sharply bounded at the interior, which appears similar to the predominant plessite. Only a few fields cross the complete lamellæ, which are about 0.05 mm. in breadth, and run out—as a rule at both ends, though at times only at one end—into the principal lamellæ so that their tænite border unites with that of the latter.

Bella Roca belongs to those irons which are distinguished by the number and size of the schreibersites, their shape being partly elongate-prismatic, and partly elongate lenslike. On a plate having a surface of 300 sq. cm. besides many smaller individuals, I counted 20 prismatic crystals 5 cm. in length. They are usually oriented parallel to the lamellæ. Swathing kamacite is not distinguished from the rest of the kamacite. Two plates showed a different magnetic relation. One which was nearly square took very strong magnetism; the other which was nearly as long as broad, only weak magnetism. The former showed, according to the investigation of Leick, a specific magnetism of 1.68, the latter of 2.39 absolute units per gram. Specific gravity=7.8244.

Cohen[11] also reports an analysis by Knauer as follows:

Fe	89.68
Ni	9.78
Co	0.55
Cu	0.02
Cr	Trace.
P	0.31
S	0.05
	100.39

The meteorite is distributed, the largest mass being in the possession of the Vienna Museum.

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BETHLEHEM.

Albany County, New York.
Latitude 42° 37′ N., longitude 73° 45′ W.
Here also Albany County, 1859, and Troy.
Stone. Crystalline spherulitic chondrite (Cck) of Brezina.
Fell 7.20 a. m., Aug. 11, 1859; described 1859.
Known weight, about 11 grams (0.4 ounce).

A full account of the meteor which produced the known stone of this fall was given by Wells[1] as follows:

On the morning of August 11, 1859, at 7 o'clock and 20 minutes or thereabouts, thermometer 73°, air still, and the sun shining brightly, a meteoric body of great size and brilliancy was observed throughout a large portion of western New England and eastern New York, which, exploding violently, threw down to the earth at least one fragment of its mass, in the vicinity of Albany, New York.

The main facts connected with this interesting phenomenon, collected from numerous and widely separated observers, are as follows:

By observers, generally, north of Albany, the meteor is described as appearing in the southeast, at an elevation of from 45° to 60°; thence it passed rapidly to the south, and disappeared a little west of south, at an elevation of from 10° to 15°. Its course, throughout its visible range, was marked by a heavy train or trail of smoke, which continued visible for some time after the meteor itself had disappeared; and at two or three points in its course, large volumes of smoke were observed to form, as if the result of successive explosions. These volumes of smoke were observed to be in a state of great agitation, and in size were compared to the cloud of smoke produced by the discharge of a 6-pounder.

To observers, generally, south of Albany (20 miles or more distant), the meteor was first seen in the northeast, and disappeared to the northwest; a fact which indicates the path of the body to have been nearly coincident with the parallel of Albany.

A few minutes after the disappearance of the meteor, the lapse of time being variously estimated by differently located observers at from 30 seconds to 2 minutes, two or three loud and successive explosions or reports were heard, accompanied by prolonged echoes and a violent concussion. These sounds have been compared by some to sharp and heavy peals of thunder, to the report attending the explosion of a powdermill, or steam boiler, and also to the rumbling of heavy carriages on a bridge. In Troy, the concussion and jarring were sufficiently intense to suggest the idea of an earthquake; people walking in the streets involuntarily stopped, and for a moment nearly every occupation was suspended. At Schaghticoke, New York, and Bennington, Vermont, where powdermills are in operation, the report was referred to as explosions at the works. At Eagle Bridge, on the Troy and Bennington Railroad, the concussion was forcible enough to jar the windows and shake the seats of a train of cars in motion. At Greenbush, opposite Albany, numbers of people rushed to the docks, under the supposition that a passing steamboat had exploded her boiler. The noise and concussion also appear to have been noticed to nearly an equal extent, at points 60 miles east of the Hudson, while the whole area over which the sound is positively known to have been *heard* with distinctness was upward of 2,000 square miles. The area of country, on the other hand, over which the meteor was *seen*, was, as might have been expected, much larger than the area over which the explosions were heard, being at least equal to 6,000 square miles. Thus, observations were made upon it at Morristown, Lamoille County, Vermont, 25 miles north of Montpelier, and at South Manchester, Connecticut, a point nearly 200 miles south; it was also observed at localities west of the Hudson River, and at various points from 30 to 50 miles east of the Hudson. Within a radius of 30 miles northeast and southeast of the city of Troy it was probably observed by every person out of doors who was at the time looking in a southerly direction; yet such is the unreliability of human testimony as regards natural phenomena that no two observers can be found to agree as to many important particulars, such as apparent size, period of visibility, direction, altitude, etc.

The estimates formed of its size are exceedingly discrepant; some observers comparing it to the sun, or full moon, and others to a skyrocket, or the luminous ball projected from a Roman candle. All agree, however, that its appearance even in full sunshine was exceedingly bright and dazzling, the light being at the same time of a reddish color. So

bright, indeed, was it at Strafford, Vermont, a locality nearly 100 miles north of the probable point of explosion, that its distance was estimated as not exceeding a half mile from the point of observation.

A single fragment only of the meteor is positively known to have fallen. This was found in Bethlehem, Albany County, New York, and at a point about 10 miles west of Albany. The circumstances connected with the phenomenon related by the person who noticed it are as follows:

While standing in the inclosure adjoining his house, his attention and that of his family was attracted by a loud sound, overhead, which somewhat resembled thunder; and a few minutes after a stone struck the southeast side of a wagon house, and bounding off, rolled into the grass. A dog lying in the doorway started up and ran to the place where the stone fell. When picked up immediately after, it was found to be quite warm, and possessed of considerable sulphurous odor. The fragment in question was small, about the size of a pigeon's egg, and irregularly shaped. Nearly three-fourths of its superficies was covered with a black, nonlustrous, evidently fused crust, while the remainder presented the appearance of a fresh fracture, and was of a light-gray color, and of a granular or semicrystalline texture. Its composition was apparently siliceous and not metallic. This specimen was bought by the regents of the University of the State of New York, and is now deposited in the State cabinet at Albany. Other fragments are reported to have fallen in the vicinity of the Hudson, but careful inquiry has thus far failed to discover them.

From the above facts it seems evident that the meteor of August 11 was of immense size, probably of tons weight, and that it exploded violently at no great distance above the surface of the earth. It is also an interesting subject of speculation as to what became of the other fragments, and also of what the smoke so abundantly developed during its course was composed.

The first description of the stone was given by Shepard[2], as follows:

The only stone found from the great explosion heard over a large district of northwestern Massachusetts, and extending into the State of New York as far as 10 miles west of the cities of Albany and Troy, was the little fragment, less in size than a pigeon's egg, of which an outline is here subjoined.

I am indebted to David A. Wells, Esq., the editor of the American Scientific Annual, for several interesting particulars concerning its discovery and properties. He was good enough to visit, at my request, the residence of Mr. Garritt Vanderpool (situated 7 miles from Albany and 1 mile west of Bethlehem Church), where the stone fell, and to ascertain on the spot the facts respecting its descent. Mr. Vanderpool was at work near his house, and heard the explosion in common with other members of his family. About two minutes after, as it appeared to him, a stone, coming in an oblique course, struck the side of a wagon house, glanced off, hit a log upon the ground, bounded again, and rolled into the grass. A dog lying in the doorway of the wagon house sprang up, darted out and seized it, but dropped it immediately, probably on account of its warmth and sulphurous smell. Mr. Wells had two opportunities of inspecting the stone before it was sold to the State Cabinet at Albany. It was far from being entire when first picked up, no doubt having been broken by its contact with the house. On the second inspection, he noticed that one corner had been broken away, and other portions much marred through the use of knife blades upon its surface by the curious, who, in this rude way, had been led to investigate its peculiarities. About "one-half of it, however," he observes, "is covered with the peculiar dark colored crust of meteorites, and has a burnt appearance. This is so well marked that it at once establishes its identity as a meteoric stone. The other sides presenting the appearance originally bright and of a fresh fracture were clear, but are now soiled from handling. The color is a light steel-gray, with metallic particles interspersed. The structure is granular."

Through the recommendation of His Excellency, Governor Morgan to the officers having in charge the State Cabinet, a small fragment of the stone, including a portion of the crust, was most obligingly transmitted to me by Mr. Woolworth, accompanied by the following note:

"ALBANY, *Nov. 11, 1859.*

Prof. CHARLES U. SHEPARD.

DEAR SIR: I am directed by Governor Morgan, as chairman of the committee of the regents of the University on the State Cabinet of Natural History, to send you the inclosed portion of the aerolite lately found near this city. The committee had hopes of finding other parts of the stone than the one first discovered, but have not been successful. They regret they can not send you more, but could not do so without destroying the specimen they possess. Hoping it may be sufficient for your purposes, I am, very truly, yours, &c.,

J. B. WOOLWORTH, *Sec'y, &c.*"

I am likewise much indebted to Henry A. Homes, Esq., the State librarian, for his good offices in facilitating my early acquisition of the specimen which enables me to compare it with those I possess from other localities.

The crust of the Bethlehem stone is very peculiar. It is double the thickness of any in my collection, equaling that of thick pasteboard. It is perfectly black, and very open in its texture. The outer surface is rough, being nowhere perfectly fused, but only semivitrified. Without being fragile or carbonaceous, it nevertheless resembles in color, luster, and porousness, certain surfaces of mineral charcoal. The interior of the stone is equally peculiar, being loosely granular, the particles being uniform in character, small, highly crystalline, and nearly transparent. They possess a brilliant luster, a very light gray or greenish white color. They resemble volcanic peridote more than any species of the augitic or feldspar family. Nickelic iron, of a bright white color, in delicate filaments and semicrystalline grains, is thickly diffused through the mass; and these grains, as well as those of the peridotic mineral, are flecked with brilliant points of pyrrhotine (FeS). The specific gravity is 3.56. In general color and effect to the eye, it approaches nearest to the Klein-Wenden stone (September 16, 1843); but it differs from this in being larger grained, and looser in its texture.

According to Brezina [4] the ground mass is composed of rather loose, glassy, and crystalline grains, somewhat similar to Lodran, with the chondri, however, remaining entirely whole.

The most of this meteorite that is preserved is in the New York State Museum at Albany, N. Y., as the present writer is informed by a letter from Director Clarke. The amount there preserved is 8.2 grams.

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2. 1860: Shepard. Amer. Journ. Sci., 2d ser., vol. 30, pp. 206–207. (Outline sketch of the stone of the size of a pigeon's egg.)
3. 1863: Buchner. Meteoriten, p. 102.
4. 1895 Brezina. Wiener Sammlung, p. 259.

BILLINGS.

Christian County, Missouri.
Latitude, 37° 10′ N.; longitude, 93° 30′ W.
Iron. Coarse octahedrite (Og) of Brezina.
Found 1903.
Weight, 24.5 kgs. (54 lbs.).

This meteorite was described by Ward [1] as follows:

A new siderite is now added to the six meteorites (four siderites and two aerolites) already found in the State of Missouri. The mass was found on the farm of George Wolf, about 4 miles east of Billings, Christian County, southwestern Missouri, in breaking new ground in September, 1903. It was taken by Mr. Wolf, who considered it an iron ore, to a street fair held in Billings in the same month, where it took the first prize as iron ore. The attention of J. P. Thomas was called to it, and he had a horseshoe nail made from a piece of it and a hole drilled through the edge of the mass to test its quality. Mr. Thomas shipped it with a large number of specimens of iron ore to Kansas City, Missouri, where it was bought by Mr. R. E. Bruner, a gentleman who possesses a fine collection of minerals. It remained in Mr. Bruner's hands until I obtained it from him last November.

In general shape the Billings siderite rudely resembles an ax or hatchet. Its extreme length is 15.25 inches; its greatest breadth 8.75 inches. The thickness at the larger end is 5 inches, while from the middle the mass flattens out into a blade or wedge, which is about 3 inches thick on a medium line, and slopes off to a blunt rounded edge at the sides and end. This iron has evidently lain in the ground for a long time since its fall. Its outer surface is rusty and covered with flaking scales of oxide. There consequently remains upon its surface no sure trace of "pitting" or other aerial action incident upon its flight and fall through our atmosphere. A single circular concave depression, 4 inches across by 1 inch in greatest depth, on one side of the mass may be the remains of an original pitting on the original surface. The weight of the mass before cutting was 54 pounds. Several slices have been made under my direction which show fine Widmannstätten figures of the octahedral system. Of the structure and composition of the iron alloys inducing these figures I am indebted to Prof. Oliver C. Farrington, of the Field Columbian Museum of Chicago, for the remarks which follow.

The Billings iron is a coarse octahedrite (Og), with lamellæ averaging from 1 to 2 mm. in width. In length many of the lamellæ extend 2 mm. without interruption. They are, as a rule, comparatively straight in outline, but again become irregular and swollen and at times merge into areas where their outlines are so nearly rounded as to give a coarse-granular appearance. The substance of the lamellæ is sometimes interrupted and sometimes shows subdivision longitudinally into narrower bands by more or less continuous films of tænite. The kamacite is coarsely granular in character and shows oriented sheen. The tænite appears as a dark narrow line, in general bordering the kamacite, but also not infrequently crossing and anastomosing. In portions of the meteorite, where some decomposition has taken place, the tænite separates out as thin, flexible, magnetic plates of a tin-white color.

The meshes of the section occupy but small space relatively to the bands, but are well defined where they occur. They range in size from about 25 sq. mm. down, and in outline from triangular to trapezoidal. They are filled with a substance darker in color than the kamacite, and are traversed by irregular numbers of delicate plates seen only under the lens, which run now in one and in several directions. As a rule these plates start in great numbers from the borders of the mesh and thin out toward the center, but in some of the meshes they extend uniformly across. Several nodules of troilite appear in the section examined and as usual occur near its boundary. One of these nodules is irregularly oval in shape and has a diameter of about 1 cm. The others are smaller and range in outline from nearly circular to considerably elongated. None of them has a border of swathing kamacite. A line of irregular parting extends across the section following roughly the lamellar planes, except at about the middle of the section, where it runs nearly straight for a distance of about 2 mm. quite irrespective of the lamellar structure. The parting at this point has a width of about 1 mm. and is filled with a substance of the section. This substance shows a foliated structure parallel with the length of the parting, some of the foliae suggesting by their luster and color tænite, others kamacite. The structure is evidently secondary in character and appears to be a filling subsequent to the individualization of the main mass.

The chemical analysis of the iron has been made by Mr. H. W. Nichols, the chemist of the Field Columbian Museum, and is as given below:

Fe	91.99
Ni	7.38
Co	.42
Cu	.01
Si	.08
P	.15
S	.06
	100.09

The larger part of this Billings siderite has taken its place in the Ward-Coonley Collection of Meteorites.

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BISHOPVILLE.

Sumter County, South Carolina.
Latitude 34° 13′ N., longitude 80° 16′ W.
Stone. Veined chladnite (Chla) of Brezina; Chladnite (type 52) of Meunier.
Fell March 25, 1843; described 1846.
Weight, 6 kgs. (13 lbs).

The first mention of this stone seems to have been by Shepard [1] in 1846 in a description of the minerals of meteorites. In this account he mentions hyposulphates of magnesia and soda (epsom and glauber's salts), chlorides of calcium and magnesium, and soluble silica, as dissolved from the Bishopville stone, and he remarks that sulphurous acid is evolved from the stone by fresh fracture or slight friction. He describes three new species to which he gives the names apatoid, iodolite, and chladnite, the latter forming more than two-thirds of the stone.

In 1848 Shepard [2] described the phenomena of fall and the characters of the stone as follows:

For my first knowledge of this, the most remarkable of all the hitherto described meteorites of the United States, I am indebted to Dr. J. C. Haynsworth, of Sumterville, South Carolina. His letter to me, dated April 7, 1846, which is here given, contains all the information respecting its fall, which I have thus far been able to obtain. "I have in possession a meteoric stone which fell in March, 1843, near Bishopville, in the northern part of Sumter district. The passage of the meteor and its explosion were witnessed by many spectators, over a region of country of 30 or 40 miles in diameter. The descent of the stone itself, also, was observed by a number of negroes. Their terror was so great on seeing the excavation it produced, the scattering of the soil, and more than all by the insupportable sulphurous odors with which the air was filled, that they fled in a panic from the field. On the following morning, however, headed by a white man they returned to the spot, and after digging 3 feet or more in a sandy soil they came upon the stone which I now possess. That it is meteoric is as well known as possible, perhaps, in the absence of a scientific analysis. It has more the appearance of limestone than of any other rock with which I am acquainted, though it is much heavier than the same bulk of limerock. It has, moreover, numerous particles resembling oxide of iron diffused through it. It is coated with a dark shining surface, resembling glass that has been stained with some metallic oxide. When first dug up the sulphurous odor was said to have been overpowering. This has now subsided, though it can be reproduced by friction or slight warmth. It begins to suffer decomposition from the access of air and moisture to the interior, as portions of the vitreous coating have been removed for specimens by persons who have examined it."

The stone was purchased for me by Dr. Haynsworth and is now in my possession. Its weight was 13 pounds.

It measures 9 inches in its longest diameter by 5.75 and 5 in its transverse dimensions. It is rounded at its thicker extremity, from whence, after bulging somewhat, it gradually tapers to the smaller end, which is obviously pyramidal, with four sides.

Being an uncommonly fragile stone, the glazed coating had disappeared from the angles and the ends of the mass, leaving not more than two-thirds of the surface protected by the original crust, which is generally smooth, of a mottled aspect, the colors being black, white, and bluish gray, not unlike certain clouded marbles. The black portions are glossy and obsidianlike, the gray and white for the most part dull, though the white is sometimes shining and transparent, like enamel on porcelain. It is traversed by frequent cracks or fissures, which penetrate for some distance into the stone, the walls of these fissures being themselves partially fused for a little way inward from the exterior.

The interior view of the stone is no less peculiar. The pearly white color of its basis and its feldspathic crystallization, at first view, make it difficult to regard it as anything else than a decomposing mass of albitic granite. A nearer inspection, however, satisfies the observer that the white substance (chladnite, which is nearly as tender as laumontite) is different from any terrestrial mineral. It is seen, moreover, to be traversed with little black veins, and here and there to include little grains of deeply rusted nickeliferous iron, some of which are as large as a pea. Black grains and even

crystals of sulphuret of chromium (schreibersite resembling allanite in form and color) are occasionally visible. Brown-colored pyrites, in very minute quantity, is diffused through the stone, and especially is it visible in contact with the sulphuret of chromium. A peculiar blue mineral (iodolite) and a honey-yellow one (apatoid), as well as traces of sulphur, are likewise present in traces in the stone.

Wherever the stone is broken or rubbed, it emits the odor of sulphurous acid. Water dissolves from it decided traces of hyposulphate of soda, hyposulphate of magnesia, sulphate of magnesia, chloride of magnesium, chloride of sodium, and silicic acid.

The proportions in which the different visible minerals are present may be thus expressed:

Chladnite	90
Anorthite	6
Nickel-iron	2
Magnetic pyrites, Schreibersite, Sulphur, Iodolite and apatoid	2

The above minerals have been described mineralogically in my previous report. It only remains to state the results obtained in the analysis of the chladnite. They are the following:

		Oxygen.	Ratio of oxygen.
Silicic acid	70.41	35.205	3
Magnesia	28.25	11.300	1
Soda	1.39	.338	.....
	100.00		

It consists, therefore, of 11½ atoms tersilicate of magnesia + ½ of an atom of tersilicate of soda.

In operating upon the mixed powder of the stone, lime, alumina, and phosphoric acid were detected, ingredients which are supposed to have reference to anorthite and apatite.

Three years later von Waltershausen[3] gave an account of an analysis of a small portion of the meteorite as follows:

In connection with various investigations concerning feldspar, with which I have occupied myself recently, I became interested in the determination of the composition of a meteoric mass which fell at Bishopville, South Carolina, in March, 1843, from a small fragment of 10 to 20 mm. in length which was presented by Professor Shepard to Mr. Clark, a student of chemistry.

Some of these fragments possess a glaze peculiar to these formations of about 0.3 mm. in thickness and of a brighter color than is usually seen. The principal part of the stone is composed of a white mineral, rich in silica and of fine crystalline structure, in which are scattered here and there specks and grains of a metallic luster consisting of magnetic pyrites and brown oxide of iron, which presumably was formed from the pyrites. The hardness of this white mineral, sometimes of a slightly silken luster, is 6. The specific gravity is 3.039.

The analysis gave the following result:

Silicic acid	67.140
Magnesia	27.115
Calcareous earth	1.818
Alumina	1.478
Iron oxide	1.706
Water	0.671
Manganese	trace
	99.928

A glance at the analysis suffices to show that we have no feldspar to deal with here. In order, however, the better to determine the true composition of this mineral, the iron oxide was treated as a foreign body evidently added to the compound, and the analysis then reduced to 100, with the following atomic weights:

Silica	566, 820	Pelouze.
Magnesia	250, 500	Scheerer.
Calcareous earth	351, 651	Berzelius.
Alumina	641, 800	Do.
Water	112, 480	Do.

the composition then is:

		Oxygen.
Silica	68.356	36.180
Magnesia	27.606	11.020
Calcareous earth	1.851	0.526
Alumina	1.504	0.703
Water	0.683	0.607
	100.000	

This analysis makes it very probable that the mineral consists principally of silicious magnesia, with which, however, is mixed a small quantity of calcareous labradorite, disregarding for the latter:

		Oxygen.	Ratio of oxygen.
Silica	2.657	1.406	6
Alumina	1.504	0.703	3
Calcareous earth	0.824	0.224	1

There remains for the first compound—

Silica	65.699
Magnesia	27.606
Calcareous earth	1.027
Water	0.683
	95.015

Reducing the calcareous earth to magnesia and likewise, after Scheerer, the water to the same basis, making Mg=3H=(H), we have in 100 parts of the mineral—

		Computed ac. Mg Si.
Silica	69.493	69.350−0.143
Magnesia	30.507	30.650+0.143

After completing this analysis I noticed that Professor Shepard had already bestowed much attention upon this meteoric stone, and as he was possessed of a very considerable mass of the meteorite he would be able to make numerous investigations, while I had but 200 milligrams at my disposal.

He announced as the principal ingredient of this meteoric stone a trisilicate of magnesia, without, however, having made an analysis, and named the mineral chladnite, a name which I retained.

The analysis just given shows, nevertheless, that the chladnite consists of siliceous magnesia (MgSi), and that the meteoric stone is compounded of 95.015 of the same and of 4.985 of feldspar resembling labradorite.

The chladnite is most closely related to wollastonite (CaSi) among terrestrial minerals, with which the specific gravity, color, texture, hardness, and crystallization closely conform. Small, entirely microscopic crystals, which I distinctly observed, did not show the monoclinic system, and have the form of a figure shown. Specific measurements were not to be had.

The chladnite is readily cleavable, parallel $\infty \overline{P} \infty$.

Regarding the chemical relations of chladnite it is to be remarked that I did not omit to test for heavy metal, but no trace of such was obtained. It is possible, however, that the admixture of iron oxide and the grains of magnetic pyrites may contain small quantities of nickel, etc.

Shepard stated that the Bishopville stone contained hyposulphurous magnesia and sodium, which can be washed out with water. I made this experiment with a very small quantity of material. Traces of calcareous earth and magnesia were noticed in the watery extract, but they were so small that they almost escaped observation and made at best but an extremely small part of the composition of the meteorite.

The wollastonite belongs to those bodies whose volcanic formation can not be disputed. The most indubitable of these are shown by the great lava stream which lies thick before Rome from the foot of the Alban Mountains to the Capo di Bove and is there used for street paving. The thick gray lava there contains nepheline, leucite, and wollastonite, mineral bodies which frequently, in consequence of rapid cooling, can only be isolated in crystalline masses, not in distinct crystals.

I am inclined, therefore, to ascribe to the chladnite the same formation, and conjecture accordingly that this meteoric stone, just after the analogy of the formation and oxidation of the terrestrial bodies we have examined, once was in a state of complete fusion, from which, by cooling, magnetic pyrites, labradorite, and chladnite must have been separated. We are then compelled to concede as important a rôle to oxygen in the composition of bodies in extraterrestrial as in terrestrial regions. It is, finally, more than probable that this meteoric mass, upon entering our atmosphere underwent a second fusion process, in consequence of which the glaze on the exterior of the stone was produced.

We have a similar terrestrial phenomenon, doubtless never yet described, which is still better suited to support this view. The labradoritic lavas on especially prominent parts of Ætna are not infrequently struck by lightning, and upon the exterior, although only in small streaks, they are melted to a glaze which can scarcely be distinguished from the glazed crust of this meteoric stone.

In 1855 Smith [4] remarked that investigations which he was making seemed likely to show that chladnite was a pyroxene.

Rammelsberg [5] in 1861 carefully investigated the composition of the meteorite and gave his results as follows:

This very noteworthy stone fell in March, 1843, in the northern part of Sumter County. Professor Shepard, in his monograph on North American meteorites, gave the approximate circumstances of the fall and the original weight of 13 pounds and described the outward appearance of the stone. Under a black to bluish-gray glassy or porcelain-like crust the interior mass appears of a white crystalline character and, as Shepard expressed it, more nearly resembles a disintegrated albite-granite than a meteoric stone. Shepard gave the name chladnite to this white principal mass. It is distinguished by great brittleness, and it seems as if many places were already altered by weathering.

After Shepard, Sartorius von Waltershausen interested himself in this white mineral. The former observed thereon single crystals, sometimes at most an inch in size, whose form resembled in general that of feldspar but whose faces were rough, unfit for measuring. Two fracture planes are easily distinguished. Sartorius found the chladnite similar to wollastonite and speaks of two and one branched, although microscopic, crystals. The specific gravity is, according to him, 3.039, and according to Shepard, 3.116.

The composition of the so-called chladnite as given by both the above is very peculiar.

	Shepard.	Sartorius.
Silicic acid	70.41	67.14
Alumina		1.48
Iron protoxide		1.70
Magnesia	28.25	27.12
Lime		1.82
Sodium	1.39	.....
Water		.67
	100.05	99.93

If the above bases of the magnesia be added the whole would have the composition magnesia-trisilicate, a combination not hitherto known among minerals. The nearest to it is a mineral investigated a long time ago by Stromeyer, which is said to resemble olivine and to be contained in an alleged iron mass found near Grimma, but this substance is basic and contains essential iron protoxide.

Silicic acid	61.88
Magnesia	25.83
Iron protoxide	9.12
Manganese protoxide	.31
Chromic oxide	.33
Loss by heating	.45
	97.92

Stromeyer's conjecture, that it was a trisilicate, is not correct, since the proportion of oxygen of the base and the acid is 1:2.6, from which, assuming 1: 2.5, the composition may be expressed by $2MgSi+Mg_2Si_3$ or $3MgSi+MgSi_2$. It is to be regretted that nothing more definite concerning this mineral is known.

The conjecture of Sartorius von Waltershausen that 5 per cent of a sodium-free labradorite is included, to which he relates the alumina, seems to be unfounded.

Through the kindness of G. Rose and Dr. Hörnes, of Vienna, I obtained a sufficient amount of the rare material to undertake some experiments with the principal mass of the Bishopville stone. I observed no signs of crystalline structure, except indeed the ready cleavage of the, for the most part, extremely pliable and friable mass. The colored portions of the crust and the yellowish-brown and bluish-green particles of the interior of the mass are very well distinguished. The former appeared as if produced by the weathering of iron sulphide or by the oxidation of iron. In fact, a few metallic particles were isolated with the magnet, but these were much too little for further examination. Shepard also stated that the stone contained, here and there, small grains of nickel-iron much rusted, as well as a small amount of brown iron sulphide.

I first treated the fine powder from the stone with concentrated hydrochloric acid and heated the undissolved portion with a solution of carbonate of soda. There remained a residue of 90.75 per cent, while the decomposed portion consisted of—

Silicic acid	2.29
Iron oxide	.97
Manganese protoxide	.20
Magnesia	3.51
Lime	.58
	7.55

Thereto must be added 0.8 per cent of moisture, and possibly also some alkali. What the acid dissolved is evidently no unusual compound, but a mixture of oxide of iron (or rather hydrate) and the principal mass, the silicic acid of which could not be completely separated from the unaffected portion.

This latter was divided into two portions and dissolved with carbonate of soda as well as hydrofluoric acid, after which 100 parts of the mass contained:

Silicic acid	60.86
Alumina	3.00
Iron oxide	.31
Magnesia	34.48
Lime	.11
Sodium	1.26
Potash	.93
	100.95

If this result be reduced to 90.75 per cent and the constituents of the decomposed portion be added, we have—

Silicic acid	57.52
Alumina	2.72
Iron oxide	1.25
Manganese protoxide	.20
Magnesia	34.80
Lime	.66
Soda	1.14
Potash	.70
Loss by heating	.80
	99.79

Next arises the question, Is this one compound or a mixture of several? I conjecture the latter, because the alumina points to the presence of a small amount of silicate, and my own experiments deviate so widely from the former investigation, according to which the nearly 70 per cent of acid seemed strange in every case.

The stone affords no opportunity for mechanical separation, however, since the white mass shows no other variation than that of greater compactness in certain places. I washed it and examined the lightest as well as the heaviest for essential constituents, not at all in the hope of effecting a division of the constituents thereby, but merely with the object of determining definitely the similar or dissimilar composition of both portions.

I obtained the following:

Silicic acid	58.74	57.12
Alumina	6.16	2.13
Oxide of iron	1.82	2.71
Magnesia	29.78	36.71
Lime	1.70	1.48
Loss (alkali)	1.80	.....
	100.00	100.15

Thus, in fact, both are different, the alumina and alkali bearing silicate being especially noticeable in the lighter portions.

After this it appears entirely needless, for the present, to speculate concerning the nature of this compound. But I do not omit to emphasize the fact that the chladnite and the supposed magnesia trisilicate appear as notable exceptions, and further call attention to the fact that the composition of the groundmass of the stone from Bishopville, as determined by me, shows a great similarity with that of the substance investigated by Stromeyer, if the iron protoxide of the latter be converted into its equivalent magnesia.

Rose[6] described the meteorite as follows:

The group Chladnite contains only one meteorite. This fell at Bishopville, South Carolina, in March, 1843. There fell only one stone weighing about 13 pounds, which was acquired after its fall by Professor Shepard, to whom we owe the first description and analysis. Afterwards Sartorius and Rammelsberg made investigations of it. The Berlin collection possesses a large piece weighing 4.86 ounces and smaller ones. The stone has very slight cohesion and falls in pieces at the slightest pressure. It is in general of a porphyritic granular structure. In a gray, spotted with white, finely granular groundmass there occur, besides some smaller ingredients of lesser importance, only snow-white crystals of different sizes in great quantity. The largest crystal of the piece in the Berlin Museum shows on the surface of the stone a section of rectangular shape with truncated angles. It is 0.5 inch long and somewhat less broad. Another shows the shape of a symmetrical hexagon with two parallel sides over 0.5 inch long and a little less than 0.25 inch broad. The first two crystals are penetrated by parallel cleavage faces which are, however, not complete but broken by intervening fracture. The fractured surface has a pearly luster and is traversed by dull striæ parallel to the longer side. The origin of these I do not know, but one sees them on sections of other crystals as well as the bright cleavage surfaces in another direction. There occur also round white grains about the size of a pea, which are, however, not all round, for when taken out they leave uneven hollows in the stone. They are transparent with vitreous luster. When one takes the crystals or grains out of the stone they fall into little pieces on account of being penetrated in different directions with many straight and curving clefts. It is probable that the grains are different from the crystals, and probably also that these are distinguished by the bright and striated cleavage surfaces. Shepard mentioned the round grains and separated them from the crystals. He regarded the former as anorthite, without, however, further testing than with the blowpipe. The crystals he regarded a new mineral, to which he gave the name chladnite and which he has allowed me to change to shepardite. Of the form of these shepardites he made no record, although he mentions crystals nearly an inch in diameter. In general they have, according to him, the appearance of common forms of feldspar and calcite. The original form was a double prism. By cleavage, which takes place easily, angles of 120° and 60° are observed. Sartorius also speaks of the form of these crystals and compares it with that of wollastonite without giving further angles. He only mentions the small microscopic crystals and does not state how these occur. The hardness of the shepardite is, according to his observation, that of feldspar. The

specific gravity, according to Shepard, is 3.116; according to Sartorius, 3.039. Before the blowpipe shepardite fuses only on the edges to a white enamel; in the form of a powder it dissolves easily to a clear glass. In salt of phosphorus pieces of the mineral are slightly fusible, but in powder it easily forms a glass which, though it contains a skeleton of silica, is transparent as long as it is hot. On cooling, it opalizes. It is attacked with difficulty by hot hydrochloric acid. This is true also of the round grains which Shepard considered to be anorthite. On powdering finely and boiling a long time with hydrochloric acid a diluted and filtered solution gives with ammonia after some time brownish flakes. If I investigated grains of the same kind as Shepard, this can not be anorthite.

The chemical composition of the shepardite according to the three analyses is as follows:

	Shepard.	Sartorius.	Rammelsberg.
Magnesia	28.25	27.12	34.80
Lime	.....	1.82	.66
Soda	1.39	.....	1.14
Potash	.....	.....	.70
Manganese oxide	.....	.....	.2
Alumina	.....	1.48	2.72
Iron oxide	.....	1.70	1.25
Silica	70.41	67.14	57.52
Water	.....	.67	.80
	100.95	99.93	99.79

According to Shepard, the shepardite, except for a small quantity of soda, is a mixture of silica and magnesia. Shepard alone found no aluminum, probably because he used only the purest crystals for analysis. He also had a larger quantity than the other chemists, who had only small pieces. Shepardite has also the same constituents as olivine in different quantity. It has oxide of magnesia in proportion to silica as 1 to 3, while in olivine it is 1 to 1. It has the calculated composition—

Magnesia	30.2
Silica	69.8

Sartorius, thinking that he had a mixture, concluded that the alumina found was from labradorite. From this he reckons a mixture of 5 per cent of the latter. Deducting this, he obtains a formula for shepardite. This does not seem to me warranted, for labradorite of such composition is not known, and no crystals of this form can be recognized. In the chladnite a mixture of anorthite seems more probable, but this is not certain. Rammelsberg first digested the fine powder with concentrated warm hydrochloric acid, and then treated the residue with sodium carbonate. The acid only dissolved 7.55 per cent, indicating only a partial decomposition of the shepardite. He was also convinced that he was treating with a mixture, from the fact that he separated a considerable quantity of the powder of the white crystals by sliming, and analyzed the lightest and heaviest. In this he found some differences of composition. He concluded, therefore, that no formula could be established for the composition of the whole. Although it can not be doubted that chladnite is a mineral species, it is also probable that another alumina-bearing mineral is contained with it. The other ingredients are as follows:

(1) Nickel-iron, partly in the groundmass and partly in and between the white crystals in small quantity in small grains. They have, according to Shepard, at times the size of a pea. In the piece in the Berlin collection I observed many pieces not much smaller. The iron is always covered with iron oxide, and this has colored the surrounding mass brown more strongly than is usual in meteorites. On scraping the larger grains with a knife, however, the metallic, light, steel-gray color of nickel-iron can be recognized.

(2) Iron sulphide occurs in small grains rarely.

(3) There occurs also a black mineral called by Shepard chromium sulphide. He named it schreibersite for Schreiber. This Haidinger changed to shepardite. When the mineral is more completely determined, a new name should be given it. It occurs in small grains or small veins which penetrate the chladnite, and, according to Shepard, also in small prismatic crystals striated on the sides and showing traces of cleavage faces. The mineral has an imperfect metallic luster, is opaque, and has the hardness of fluorspar. Before the blowpipe it melts with difficulty to a thick glass, and when heated in the crucible it gives a sublimate of sulphur. With borax and salt of phosphorus it forms a green glass. The color is shown strongly, but stronger in the borax glass than in the phosphorus glass, and especially by fusion in the flame and after the addition of tin.

Smith [7] in 1864 reported a study of the meteorite as follows:

Several years after this examination (Shepard's), a fragment of this meteoric stone came into my possession, and, separating a small portion of the mineral in question, it was examined. The result of this incomplete examination justified the statement in a note to a memoir of mine on meteorites, presented to the American Scientific Association in April, 1854, and published in the American Journal of Science for March, 1855, "that from some investigations just made, chladnite is likely to prove a pyroxene."

Since that announcement I have been placed in possession of other fragments of the meteorite, and have been able to separate the "chladnite" perfectly pure, and in sufficient quantity to submit it to a thorough analysis.

To render the chladnite soluble in acid, it was fused with four times its weight of carbonate of soda and potash, with a small fragment of caustic potash placed on the top of the mixed powders in the crucible. After fusion, the analysis was proceeded with in the ordinary way; the result of two analyses were as follows:

	1	2
Silica	60.12	59.83
Magnesia	39.45	39.22
Peroxide of iron	.30	.50
Soda, with feeble potash and strong lithia reaction	.74	.74
	100.61	100.29

The minute quantity of peroxide of iron came from exceedingly fine particles of iron diffused through the minerals, and could be seen by a magnifying glass. One separate analysis was made for the soda.

The constitution of the mineral, as made out from the numbers in analysis 1, is:

	Oxygen.	Oxygen ratio.
Silica	31.22	2
Magnesia	15.51	1
Soda	.19	

corresponding to the formula Mg^3Si^2, equivalent to the general formula of pyroxene, R^3Si^2.

The excess of silica obtained by Professor Shepard in his analysis is doubtless due to an imperfect fusion of the mineral with the carbonate of soda, an error easily made, if the precautions I have already mentioned are not attended to.

"Chladnite" approaches those forms of pyroxene known as white augite, diopside, white coccolite, etc., these last-named minerals having a part of the magnesia replaced by lime. It is identical in composition with enstatite of Kenngott, a pyroxenic mineral from Aloysthal in Moravia.

From these observations it will be seen that the Bishopville meteoric stone, however different in external characteristics from other similar bodies, is, after all, identical with the great family of pyroxenic meteoric stones.

Reichenbach[8] made a number of observations on Bishopville of which the following are the most important. In Study V, pp. 476 and 477, he says:

A general survey of a hundred different meteoric stones in my possession has shown me that according to outward appearance at least three kinds of fusion crust can be distinguished, namely, those of a glassy luster, those of a dull luster, and those of a sooty appearance. Bishopville belongs to the first or glassy variety.

Consider now the glassy crust. Here Bishopville affords us a happy example which stands entirely unique among meteorites, and as a rare plant discovered for the first time upon the Alps, rejoices the heart of the botanist, so here a "heaven stone" exalts the soul of the student of meteorites, an entirely colorless, transparent crust clear as water, an aerolite, therefore, covered with a pure glass coating. The entire stone, however, is not covered with such a pure fusion crust since black specks also appear where the stone shows iron oxide from the outside, but many parts of its exterior surface are covered with a colorless, glistening glass. More distinctly than anywhere else, is it to be seen on this meteorite that its crust originates from a simple fusion of the exterior. The stone, which no one would take for a meteoric stone, is in fact entirely snow white, and contains black specks, threads, and nodules, composed of black points crowded together. The white material is a magnesia silicate, transparent under the microscope, interspersed with groups of black iron oxide grains, with here and there a crystal of pyrites. The entire exterior is melted to glass, the silicate to a simple colorless variety, the iron oxide to a black species.

The data are presented here in their simplicity, without complication with other matters, and we can follow them critically. I possess several large specimens of this beautiful American meteorite (and consider them the jewel of my collection), in which the appearance of the crust is marked by a simplicity never before observed and probably never again to be observed.

In the case of the black glassy crust, Bishopville again serves as the primary example. On all places where the iron oxide lies in the magnesium silicate, it is black. It has, accordingly, iron-glass, which is black, mingled with silicate glass, which is colorless, coloring it black and thereby forming a scaly, black meteoritic crust, isolated in the silicate glass which covers the colorless, white ground mass. Other meteorites possess no such large, pure aggregations of white ground mass, they are mostly mixed interiorly with iron oxide, metallic iron, dark-colored augite, and hornblende and are gray.

In Study XIII, pp. 359–60, he describes the structure of Bishopville as follows:

Bishopville appears at first sight composed of an amorphous ground mass and innumerable larger and smaller lumps and masses imbedded therein. These consist of granules of the size of poppy seeds, roundish, elliptical, and of all sorts of irregular forms, even to course crumbs, interspersed without visible order, usually closely compacted together in balls, and cemented in place by the ground mass. Most of them, especially the larger ones, show a foliated structure, are sectile and brittle along the lines of these folia, and have a luster upon the cleavage surfaces. They are much purer than the ground mass, entirely white, with here and there a heterogeneous spot scarcely visible to the naked eye. They lend themselves to analysis better than the substance of other meteorites, and retain their properties, but unfortunately the substance is dearer than gold, and accordingly is but little available for extensive study. Under the micro-

scope the substance appears uniformly white, with an occasional tiny black speck, which is nothing else than magnetite, only of much greater fineness than that which occurs in the ground mass. These lumps and crumbs appear throughout the entire stone as separate formations, as individuals, whose aggregation is effected by the ground mass.

The ground mass is distinguished from the inclusions first of all in this, that it is not lumpy but is like a cement which envelops the inclusions, embraces and holds them together. Further, it has no crystalline structure in general, but a granular, sometimes scaly, fracture, and finally it is by no means pure white, but is interspersed with black grains and intersected by lines of the same, so that at first sight it appears gray. It is accordingly without any comparison more mixed than the lumps or inclusions.

On p. 364 of the same study, Reichenbach confirms Shepard's report of the presence of free sulphur as follows:

A similar rarity occurs in Bishopville, namely, scattered, flat lumps of pure sulphur, of the size of half a lentil, beautiful pale sulphur yellow, not difficult to perceive, and first noted by Mr. Shepard.

On p. 375, he says:

The black bodies in the inclusions, which I have generally regarded as magnetite, judging by the color, which shows through the thin edges as brownish black, the luster, and other outward aspects, may consist of augite, hornblende, or a similar body. Under the microscope, they are everywhere much alike in appearance, always sharply distinguished from the white ground mass, always having the same play of colors and the same luster, and are always small and only occur in noticeable size where several individuals run together. This appears very distinctly in Bishopville, since in this white stone there is nothing of any account other than the black bodies, sometimes isolated, sometimes grouped, and sometimes arranged in layers. The analysis which Sartorius von Waltershausen published, however, left nothing but colorless earth and protoxide of iron. It follows directly from this that the black particles can be nothing else than magnetite.

Rammelsberg[9] made a study of the analysis of Bishopville as follows:

This meteorite, which fell on the 25th of March, 1843, at Bishopville, in South Carolina, is distinguished by its bright gray to white color, indistinctly crystalline character, and isolated white grains in the soft mass, which is cleavable in one direction.

Shepard, into whose possession the stone came, described and examined it, and there is a very careful description of its exterior aspect by G. Rose.

According to the former (Shepard) the frequently very large, snow white crystals, which form the ground mass of the stone, have a feldspathic form, but according to Rose they are not sufficiently well formed to establish this opinion, to which also their structure fails to answer. Their specific gravity is, according to Shepard, 3.116, and according to Sartorius, who compared their form to that of the wollastonite, 3.039.

From the chemical characteristic of this silicate, which, according to Shepard, comprises more than two-thirds of the stone (or as he says elsewhere, nine-tenths), the same authority states that it fuses before the blow pipe only on the edges, and is attacked only slightly by hydrochloric acid, even when heated.

According to Shepard's statement, this mineral, named by him "chladnite," consists of 70.41 silicic acid, 28.25 magnesia, and 1.39 soda, and is accordingly a tricilicate.

Later Sartorius gave as the composition of the white mineral: Silicic acid, 67.140; magnesia, 27.115; calcareous earth, 1.82; alumina, 1.478; iron oxide, 1.706; water, 0.671. Sartorius considered this as magnesia trisilicate and a calcareous aluminum silicate. The former he compared with wollastonite, which he took for a calcareous trisilicate. This is evidently wrong, it being a bisilicate.

These analytical results are, however, evidently entirely wrong. I did not analyze the crystals separately, owing to lack of material but only the total mass of the stone, but such different results were obtained that it is clear that those crystals which form almost the entire mass, can not have the composition given them by Sartorius and Shepard.

Following is my analysis of the mass of the stone (a) and the same (b) after deducting iron oxide and loss on heating; also the mean of Smith's two analyses (a) and the same (b) without iron oxide.

	Rammelsberg.		Smith.	
	a	b	a	b
Silicic acid	57.52	58.84	59.97	60.21
Alumina	2.72	2.78	.....	.....
Magnesia	34.80	35.60	39.33	39.49
Lime (Kalk)	0.66	0.67	.....	.....
Soda	1.14	1.16	0.74	0.74
Potash	0.70	0.71	.....	.....
Iron oxide (Mn)	1.45	.....	0.40	.....
Loss by heating	0.80	.....	.....	.....
	99.79	99.76	100.44	100.44

Oxygen ratios are as follows:

	Rammelsberg. b		Smith. b	
SiO_2	31.38		.....	32.11
AlO_3	1.30		.....	.....
MgO	14.24		15.79	
CaO	0.19	14.85	.....	15.98
Na_2O	0.30		0.19	
K_2O	0.12		.....	

My investigations and those of Smith show, accordingly, that the mass as a whole is a bisilicate, and the former had much purer crystal masses at his disposal.

It may accordingly be concluded with certainty that the principal part of the stone from Bishopville is enstatite= $MgSiO_3$(SiO_2,60%; MgO, 40%).

Besides this, by far the most prominent constituent, there appears to be present something of an aluminous silicate, which probably proceeds from lime and alkali. But this, as already remarked, is not feldspar, not anorthite, nor are the white grains which Shepard took for anorthite to be so considered. Washing the finely pulverized stone indicates that more aluminum and lime and less magnesia are contained in the lighter portions than in the heavier. But concerning the nature of the silicate further investigations must decide.

The stone from Bishopville contains very little meteoric iron indeed, which, moreover, is mostly oxidized and has produced specks of rust in the mass. Magnetic pyrites and chrome iron are also present, as well as calcium sulphide (oldhamite) (noted by Maskelyne in the stone from Busti).

Maskelyne [10] suggested that the yellow grains in Bishopville were oldhamite. Wadsworth [11] gave the following optical study of the meteorite:

Through the courtesy of Mr. John Cummings and the curator of the Boston Society of Natural History I have been permitted to make a microscopic examination of a small portion of this meteorite, now deposited in the collection of that society. The portion examined is a grayish-white mass resembling, as Shepard remarked, a grayish-white granite (albitic), with brown and black spots. Under the microscope it is seen to be composed of an entirely crystalline mass of enstatite, augite, feldspar, olivine, pyrrhotite, and iron. The structure is essentially granitic, and it appears to belong to the gabbro (norite) variety of the basalts as defined by myself in "Science" for March 9, 1883.

The enstatite is clear and transparent. It shows a longitudinal cleavage parallel to the line of extinction, and in some specimens this is crossed by a cleavage at right angles. It also has a cleavage which is often well marked and breaks the mineral into rhombic forms with angles, as approximately determined by several measurements, of 73° and 107°. The principal cleavage is parallel to the longer diagonal of these rhombs. It is this rhombic cleavage, probably, which has led observers to believe that chladnite crystallized in the monoclinic or triclinic systems.

The enstatite is found to contain many glass inclusions with polyhedral outlines, the planes being presumably, as is usual in such cases, the planes of the inclosing mineral. While many are arranged in the enstatite parallel to the cleavage planes, others are placed at every angle with those planes. The glass inclusions carry bubbles, microlites, and rounded lenticular forms. The last are frequently at the end of the inclusion, and in some cases show the cherry-brown color of some chromite. This material, besides forming inclusions in the glass, is in lenticular and irregular rounded grains in the enstatite itself. It sometimes extends in a series of grains across the entire enstatite mass and at others is in isolated forms. These inclusions microscopically are seen to be composed of a center of nickeliferous iron or pyrrhotite, surrounded by a band of dark material, chromite or magnetite possibly. These ferruginous materials are in many cases surrounded by a yellowish-brown staining of iron which sometimes extends over a considerable portion of the mass and along the fissures. Along one plane in the enstatite numerous vacuum or vapor cavities were observed. The inclusions are seen to be crossed and cut by the cleavage and fissure planes of the enstatite, showing that they were of prior origin to the fissures.

The feldspar stands next in abundance to the enstatite and is in irregular masses held in its interspaces. It is water clear and almost invisible by common transmitted light. Much of it is seen to be plagioclastic; but the twinning bands are so exceedingly fine and the polarization of colors so bright it does not as a rule show well this character, except with high powers and when the mineral is near the point of extinction. The feldspar contains numerous yellowish-brown, dark, and almost colorless inclusions, sometimes irregularly scattered but more commonly arranged along planes like the fluid inclusions in quartz. These glass inclusions are of various dimensions and many contain a small bubble. Some microlites were also seen.

In the feldspar at one end of a section the enstatite was found in minute crystals extending outward from a center forming stellate or rosettelike forms. The structure is like that observed in terrestrial rocks in minerals formed from alteration or solution. This apparently might have been produced in this case, either by the rapid crystallization of enstatite material of a liquid feldspathic mass or by secondary alteration through water action on the rock itself. The absence of any other signs of alteration, except in the ferruginous materials, seems to negative the latter supposition. The ferruginous alteration can probably be accounted for by the absorption of moisture by this friable fissured stone since it reached the earth. The bands of inclusions were seen in several instances to extend from the feldspar through the enstatite, and in one case pass into another feldspar on the opposite side. This indicates that the cause of these inclu-

sions was a general one for the rock mass, and not limited to any one mineral. The enstatite was found in a few cases inclosed in the feldspar.

The monoclinic pyroxene or augite is less abundant and its determination less sure than is the case with the enstatite and feldspar. It is crossed by fissures in a very irregular manner, but shows in some cases the approximately right-angled cleavage of augite. In its optical characters it resembles that mineral, but its polarization is more brilliant than that of terrestrial augite and resembles that of olivine. All the transparent minerals of the section are clearer and lighter-colored than their mundane representatives, and hence tend to show in polarized light clearer and more brilliant colors. The augite is not, however, so water clear as the enstatite, but has a very faint tinge of yellowish green. The ferruginous inclusions are the same in this as in the enstatite.

The determination of the olivine is more doubtful, since it only appears in small irregular grains and masses, which hold a similar relation to the other minerals that the olivine of terrestrial gabbros usually does. From this and the fact that optically these masses are like olivine, they are referred to that mineral.

This stone in its mineralogical composition, its structure, bubble-bearing glass inclusions, and microlites is like terrestrial eruptive rocks, and it is presumable that it had a similar origin. If the common methods of lithological nomenclature were followed by the writer, it would be proper for him to give this rock a name as a rock species, but in accordance with the principles of his classification he prefers to regard it as belonging to the gabbro variety (norite) of basalt; for he holds to the essential unity of the universe and sees no necessity of employing different names according as the rock comes from above or below.

From the description of the mineral constituents of this meteorite it would seem that regarding the presence of the feldspar Messrs. Shepard and Waltershausen were correct while Rammelsberg was not. This shows the inability of the ablest mineralogical chemists to draw correct conclusions regarding the mineral constituents even of an unaltered rock. The trouble seems to reside with the instrument employed; that is, with a defect in the method. Chladnite ought no longer to be regarded as enstatite of the purest kind, as stated in most mineralogies, but rather as a mineral aggregate of which enstatite, feldspar, and augite are the principal constituents.

While these observations give an approximate solution of the Bishopville meteorite puzzle of twenty-seven years standing, it would be well if some one having larger amounts of this meteorite at their disposal could make chemical analysis of it as whole, and also analyze the minerals by the modern microscope, specific gravity, chemical method.

Tschermak [12] made the following observations on the meteorite:

Bishopville is coarse grained and consists for the most part of snow-white loose enstatite. G. Rose noted also still other white grains, which he, however, was not able to determine. According to my observations they belong to the plagioclase element. The third constituent is magnetic pyrites. The stone has a marblelike crust, sometimes colorless, sometimes black, white, bluish, and gray. The enstatite forms mostly large, but likewise small grains. On one of the latter I observed sharp outlines. The section ran almost parallel to a (100). The termination of this crystal was three-faced, one face answered to the zone *p a*, the other two, to the zones *a b*. The grains are interspersed with many fine irregular clefts, different from the cracks which were occasioned by the mechanical preparation. Inclusions are found only in small quantities, and consist of opaque grains, less frequently of black needles.

The plagioclase is mostly bound up with the small enstatite grains. I nowhere observed it having a regular boundary. Its outlines are roundish, ragged, or elongated. In polarized light a very distinct twin structure may occasionally be seen in which either broad lamellæ appear or many grains are composed of many unusually small lamellæ, so that they appear extremely fine lined between crossed nicols. The other grains have a single, common, but undulating extinction. Many are composed of several smaller grains. The behavior in polarized light is the distinctive mark of plagioclase.

An attempt to separate from the mass a few grains for further testing failed, not only because of their smallness, but also for the reason that they can not be distinguished either by their color or their luster from the enstatite.

The plagioclase shows, in places, streaks and turbidity, in which case it looks brownish in transmitted light. Small opaque inclusions occur infrequently but, on the contrary, large spindle-shaped enstatite inclusions are not uncommon. The magnetic pyrites forms larger and smaller grains, which are often covered with brown rust.

Rammelsberg's analysis agrees perfectly with the microscopic characteristics of the meteorite and the content of aluminum, lime, and alkalies corresponds to the observed plagioclase. G. Rose also gives a small quantity of nickel-iron and a black mineral, which here and there forms the filling of fine cracks. Upon breaking them I found upon such clefts a glistening armor face, such as is frequently found in the case of chondrites.

Meunier [13] grouped the meteorite as chladnite and described its structure as follows:

This is an extremely friable rock which consists chiefly of white lamellar material cemented together in a gray groundmass and contains some black grains and others of a more or less ocherous color. The rock is formed chiefly of white, opaque enstatite with a slight mixture of labradorite, nickel-iron, troilite, etc. The stone of Bishopville is distinguished first from meteorites of the common type by the nearly white color of its surface. Its fracture is irregular and easily recognized. Within are inclosed many white crystals which give a porphyritic appearance. Here and there little ocherous spots may be perceived, caused by oxidation of ferruginous components. Rarely, grains of a yellow-bronze color resembling magnetic sulphide of iron may be seen in the mass. Finally black points occur disseminated. The terrestrial rocks which, independent of their composition, most resemble this meteorite are certain varieties of porphyritic trachytes. The disseminated crystals are all grouped together and can be separated with

difficulty on account of their great friability. The meteorite has a varnishlike coating. This is marbleized gray and white with some small black veins. It is distinguished from the crust of other meteorites not only by its color but by a more lively luster in certain parts.

Tschermak [14] grouped the meteorite as chladnite and described it as follows:

This aggregate chladnite is so far known in only one meteorite, that of Bishopville. The stone is coarse-grained and consists chiefly of nearly white, porous enstatite. Rose remarked also other white grains though he did not determine them. It is my opinion that they are plagioclase. The third ingredient is troilite. The stone has a marbleized crust, partly colorless, partly black, white, bluish, and gray. The enstatite forms show large and small crystals. On one of the latter I recognized a sharp boundary. The section was almost parallel to a 100. The termination of the crystals was triangular, one face corresponding to the zone *pa*. the others to the zone *ub*. The faces are penetrated by many fine irregular clefts. Besides fissures caused in penetration, inclusions are present only in small quantities and consist of opaque grains and rarely of black needles. The plagioclase is generally united with the small enstatite grains. I have not observed a regular outline. The borders are rounded or irregular. In polarized light may occasionally be seen a very marked twinning structure, caused either by broad lamellæ in different positions or by a number of small lamellæ collected together so that they seem like fine lines. The rest of the grains have a simple and quite undulatory extinction, but many are composed of many small grains. The determination of the plagioclase rests upon its appearance in polarized light. Attempts to separate single grains for further testing failed on account of their minuteness and because they could not be distinguished either by color or luster from enstatite. The plagioclase shows streaks and delicate turbidity occasionally, and often in transmitted light appears brownish. Small opaque inclusions are rare, but large spindle-formed bronzite inclusions are not infrequent. The troilite forms large and small grains which are surrounded by a border due to reflection of light. Rammelsberg's analysis agrees with the microscopic appearance, since he found the constituents of enstatite, alumina, lime, and alkalies. Rose mentions also a small quantity of nickel-iron and a black mineral filling little clefts. On breaking I found in such clefts shining armor faces similar to those which in later-found meteorites consist of iron, troilite, and fused silicates.

The meteorite is distributed. The U. S. National Museum-Shepard collection possesses 1,090 grams; the British Museum, 512 grams; Tubingen, 510 grams. About 6 pounds of the stone are unaccounted for.

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BLACK MOUNTAIN.

Buncombe County, North Carolina.
Here also Asheville, 1835; and Buncombe County, 1835.
Latitude 35° 44′ N., longitude 82° 20′ W.
Iron. Coarse octahedrite (Og) of Brezina.
Found about 1839; described 1847.
Weight, 596 grams (21 ozs.).

This meteorite was first described by Shepard [1] as follows:

My first knowledge of this iron was derived from a remark, contained in a letter from Hon. T. J. Clingman, dated February 17, 1846, to the following effect: "Doctor Hardy informs me that he gave a very remarkable looking specimen of meteoric iron found in this county (Buncombe) to the late Colonel Nicholson, of Charleston, South Carolina, who died at Abbeville in that state, 6 or 7 years ago." Being in Charleston, I applied to the executors of the estate of

Colonel Nicholson for information respecting that portion of his effects, which would likely be to include this specimen but my inquiries were without success. Previous to this date, however, I had been informed by Professor Tuomey, who was then the State geologist, that he had seen a specimen of malleable iron in the cabinet of Doctor Barratt, of Abbeville, which led me to address a letter to this gentleman relative to the subject, from whom I received the following note, dated June 1, 1846, accompanied by the specimen itself: "I can furnish you with little that is definite concerning its history. The year Colonel Nicholson, of Charleston, died, he had obtained it in Pendleton or Greenville district. It was given to him by some person, who had picked it up as a meteorite. Colonel Nicholson gave it to me, as I was then the only person in this part of the country who preserved such objects. I believe it to be meteoric in its origin, and as such it has had a place in my cabinet. To yourself and to science it is most cheerfully tendered."

On communicating a description of the mass to Doctor Hardy, he replied, "I have no doubt that the specimen referred to is the same which I gave Colonel Nicholson. It was found at the head of Swanannoah River, near the base of Black Mountain, towards the eastern side of Buncombe County."

The fragment weighs only 21 ounces; and, judging from the size and shape of that which still exhibits the natural outside of the meteor, it is evidently a portion of a mass that must have been much larger. The texture is throughout highly crystalline, having all of the laminæ (which are unusually thick) arranged conformably to the octahedral faces of a single individual. These layers, which commonly have a thickness of one-tenth of an inch, adhere to one another with much tenacity, so as not to be separable by any ordinary force. They manifest a slight tendency, however, as a result of weathering, to separate into granular portions of the thickness of the layers themselves; the particles being somewhat oval in form—a result which seems to flow from the existence of very minute veins of magnetic iron pyrites; for when a surface of the iron is polished it exhibits the appearance of being mapped off into rounded patches by thin veins of the pyrites, and on the application of nitric acid this structure is farther developed by the corrosion of the veins. Within these areas, the structure of the iron, when etched, scarcely seems crystalline; at most, exhibiting a few faintly marked crossing lines. A somewhat similar structure is visible in the Cocke County iron.

The mass contains several rounded and irregular nodules of plumbaginous matter (from 0.5 to 1 inch in diameter), with which again (and often situated in the midst of the kernels) are found large pieces of foliated, magnetic iron pyrites. In this respect also the present iron is closely related to the Cocke County iron. Its specific gravity is 7.261. It consists of—

Nickel (with traces of cobalt)	2.52
Iron	96.04
Insoluble matter, sulphur and loss	1.44
	100.00

Brezina [3] gives the breadth of the lamellæ as 1.8 to 2.0 mm., and states that the bands are irregular.

The meteorite is distributed about equally among a number of collections. Amherst has 343 grams, which, added to 384 grams listed by Wulfing, gives more than 596 grams, the amount which Shepard stated that he originally acquired.

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3. 1885: Brezina. Wiener Sammlung, pp. 207, 214, and 234.

Blount County. See Summit.

BLUFF.

Fayette County, Texas.
Here also Fayette County and Lagrange, 1878.
Latitude 29° 55′ N., longitude 96° 50′ W.
Stone. Brecciated crystalline chondrite (Ckb) of Brezina.
Found about 1878; described 1888.
Weight, 146 kgs. (320 lbs.).

This meteorite is described by Whitfield and Merrill [1] as follows:

Found about 1878 at Bluff, a settlement on the Colorado River about 3 miles southwest of the town of La Grange, in Fayette County, Texas.

The finder, a Bohemian named Raniosek, was struck by the appearance and especially the weight of the stone, and * * * came to the conclusion that it was something foreign to the soil. He dug a hole under where it had lain in hope of finding the buried war treasures of the Mexican General Santa Anna, which were supposed by the inhabitants of that region to have been buried there by the general after his defeat at the battle of San Jacinto. For

several years the stone remained where the Bohemian had left it until he sold the land, when he removed it to his own farm, believing that it might be valuable metal. Mr. H. Hensoldt, a teacher near the place, found it here and disposed of it to Ward and Howell.

The stone showed well-marked pittings but the crust appeared only in the deeper depressions; the freshly fractured surface shows, besides the grains of metal, a greenish-gray appearance not unlike some greenstones. A particularly interesting feature of the mass was the presence of a few dark-colored veins varying greatly in dimensions.

The stone measured 58 by 46 by 28 cm., and its total weight was about 146 kg. It had a roughly rounded shape. Specific gravity, 3.510.

Analysis by Whitfield:

SiO_2	37.70
Fe	3.47
FeO	23.82
Al_2O_3	2.17
P_2O_5	0.25
CaO	2.20
MnO	0.45
MgO	25.94
NiO	1.59
Ni	0.65
CoO	0.16
Co	0.09
S	1.30
	99.79
Less O for S	0.65
	99.14

The stony portion is described by Merrill[1] as consisting of olivine and enstatite, with considerable pyrrhotite.

It has a chondritic structure which to the unaided eye is not distinctly marked, a fractured surface showing a fine-grained and evidently a crystalline-granular rock, very compact, of a greenish gray color and thickly studded with small metallic points with a brassy luster. A polished surface shows the stone to be composed of small chondri rarely over 2 mm. in diameter, thickly and firmly compacted in a fine granular groundmass. Throughout the entire mass are thickly distributed innumerable small irregular flecks of a steel-gray, brassy, and bronze-yellow color, presumably native iron and pyrrhotite.

* * * * * * * * *

Thin sections show a confused aggregate of rounded and irregular, often fragmental olivine and enstatite grains and chondri embedded in a fine granular groundmass of the same mineral composition.

The chondri occur in monosomatic and polysomatic forms composed either of olivine or enstatite alone or the two associated. Both are nearly colorless or gray on account of the inclosure of dust-like particles, and carry but few cavities. Some augite or a closely allied pyroxene and traces of plagioclase occur.

The metallic iron occurs in the usual rounded and irregular masses 1 to 2 mm. in diameter and in apparently equal proportions with the pyrrhotite, which has a bright brassy luster in strong contrast with the silvery white iron.

Newton[6] noted that the metallic grains showed a tendency to an arrangement in lines resembling Widmannstätten figures.

Meunier[3] classified the meteorite as erxlebenite and calculated its composition as follows:

Nickel-iron	7.21
Pyrrhotite	2.84
Olivine	38.01
Pyroxenes (enstatite, etc.)	45.23
Feldspathic minerals, vitreous interstitial substances, products of alteration	6.19
Chromic iron, schreibersite	traces
	99.44

Specific gravity, 3.50 to 3.75; mean, 3.547.

* * * * * * * * *

The relative disposition of the constituent minerals, interpreted in the light of synthetic experiments, is as follows, in the order of their concretion:

First time.—Pyroxenes and enstatite; feldspathic minerals.

Second time.—Peridotic powder filling the cavities left by the needles (aiguilles) of the preceding minerals.

Third time.—Very abundant vitreous magma, due to a later fusion of the primitive deposit.

Fourth time.—Nickel iron and pyrrhotine, cast upon the surface of the chondrites and injected into their fissures.

Fifth time.—Black minerals, arranged in very fine lines, arising from local reheating, without fusion and generally in consequence of mechanical action.

A similar complication, which is found still more prominent in many other types of cosmic rocks, furnishes a very strong argument.

Brezina [8] describes the meteorite as follows:

Bluff is not very distinctly crystalline, but stands between Ckb and Cgb, approximating more nearly to the first. The special peculiarity is the yellowish-brown to orange-red weathered crust, elsewhere found in olivine-gabbro, which in this meteorite attains a thickness of 2 to 3 mm. A large section of the stone, through the entire mass, measuring 53 by 30 cm., frequently shows a blackish infiltration from the crust in a dark green groundmass, to the depth of 2 or 3 mm., which penetrates the entire stone diagonally and obliquely, and from which blackish, sack-like apophyses, 2 to 4 cm. in width, branch out into the groundmass. The color of the fresh broken surface varies from greenish-gray, through light gray, to pistachio-green and greenish-brown. Grains of iron up to 1 cm. in size are frequently present, sometimes consisting of a grain enclosed in troilite, sometimes of loose, closely packed, roundish grains.

The black veins previously referred to were described in detail by Howell.[2] He says:

The black veins observed at several points on the surface are found to extend entirely through the mass and are arranged mainly in two sets, in each of which the veins are approximately parallel, the two sets crossing each other at an angle of about 45°. The systematic arrangement of the veins, which may be only accidental, is shown in a cross section through the center. As the planes of the veins are cut at nearly right angles by the sections, they show on each of them in approximately the same positions. This is particularly the case with the narrow vein shown at the base of the section. Although only a mere line, it is uniform throughout, and is seen in exactly the same position on all of the sections; therefore we have already revealed the plane of this vein, 15 by 4 inches, with no indications of petering out.

The irregular thick vein also maintains a nearly uniform appearance throughout the 4 inches of thickness.

The sections also reveal a number of fissures or cracks formed subsequent to veins, and doubtless at the time of the fall. A dark clouding for the most part surrounds these fissures, the darkest parts being farthest from the fissure and terminated in some cases by a dark line similar to the veins. As not all of the fissures are surrounded by this dark shading, and as some of the clouded spots contain no fissures, it argues that the coloration can not be the effect of decomposition induced by the cracks, particularly as there is no apparent effect of decomposition extending in from the surface of the stone. The clouding is perhaps older than the cracks, and formed lines of weakness which the cracks followed.

Whitfield and Merrill [1] also described a black vein as traversing the section which they examined. They stated that it had the form of an irregular fissure extending 60 mm. and varying in width from a mere line to 2 mm. The vein material was more compact and darker in color than the main mass of the meteorite, but proved on analysis to differ but little in composition except in the absence of lime. The analysis gave the following:

SiO_2	38.96
Fe	2.39
FeO	22.98
Al_2O_3	1.89
MgO	27.52
Ni and Co	3.26
S	0.26
	97.26

Specific gravity, 3.585.

The meteorite is distributed among collections.

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BOCAS.

Hacienda de Bocas, San Luis Potosi, Mexico.
Latitude 22° 12′ N., longitude 100° 58′ W.
Stone. White chondrite (Cw) of Brezina; Luceite (type 37, sub-type 2) of Meunier.
Fell November 24, 1804.
Weight (assignable) 14 grams.

Nothing is known of the size, weight, or form of this meteorite.

Castillo stated to Burkart [1] that the fragments in his possession showed a whitish-gray crystalline structure penetrated by black filaments mixed with grains of nickel-iron.

In his catalogue Castillo [3] states that the meteorite fell November 24, 1704 (*sic*), in the hacienda of Bocas, and that it is preserved in small fragments in the collection of the School of Engineers in Mexico, formerly the College of Mining. Brezina [2] classifies it as a white chondrite.

The few grams known are distributed.

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Bolson de Mapimi. See Coahuila.

BOTETOURT COUNTY.

Botetourt County, Virginia.
Latitude 38° N., longitude 79° W.
Iron. Ataxite (D) of Brezina.
Found 1850; described, 1866.
Weight, "A large mass, not easily transported on horseback."

This iron was described by Shepard [1] as follows:

> This iron was discovered about 1850 in a mass so ponderous that the finder, having attempted to transport it on horseback a number of miles to his house, was obliged to abandon the undertaking. He left it upon a stone wall by the road side, after having (with the assistance of a negro who happened along with a hammer) detached two or three small angular fragments. These were afterward given to Mr. N. S. Manross, who took them with him to Göttingen, where, in the laboratory of Professor Wöhler, he analyzed one of them so far as to determine the presence of nickel in the unusually high proportion of 20 per cent.
>
> It is whiter than most irons, extremely close and homogenous, with exception of a few minute pyritic grains. Specific gravity, 7.64. Fracture fine granular, like cast steel. It does not give the Widmannstätten figures.

Brezina [3] in 1885 referred Botetourt to the compact irons, but added: "possibly belonging to the Cape iron group."

Wülfing [4] drew attention to the fact that possibly the specimen entered in the Göttingen catalogue "1886: Virginia, North America (from a petroleum well)," and representing 1.5 gr., belongs here. The presumption based on the identity of the locality, "Virginia," is the more probable inasmuch as the date also corresponds with that of the publication of Shepard's notice and that fragments may have come to Wöhler through Manross.

An investigation of the Göttingen specimen by Cohen,[5] however, showed it both chemically and physically to be an artificial iron. From a fragment in the Vienna Museum, labelled Botetourt, 17 milligrams were analyzed by Sjöström with the following result (II computed to 100):

	I	II
Fe	85.88	82.49
Ni and Co	18.23	17.51
	104.11	100.00

The specific gravity of 0.4511 grams, at 15.7° C (Leick), was found to be 8.1860. Since this was the highest specific gravity hitherto known in meteorites, and as Shepard gave only 7.64, two determinations were made, each time in water and alcohol; these gave 8.1851 and 8.1870. The specimen showed no polar magnetism, and a specific magnetism of 0.44.

Thus both in structure and chemical composition, Botetourt resembles Babb's Mill, as Shepard also remarked; it belongs, therefore, to the group of ataxites rich in nickel, and indeed, so far as can be judged from so small a fragment, to that division which shows neither etching patches nor etching bands.

Besides the small fragments in the Vienna collection, Calcutta and Amherst report splinters of Botetourt. In view of the little that is known of the meteorite and the uncertainty with which it is surrounded it is omitted from most lists, and on the whole it is certainly unsatisfactory.

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Brazos River. See Wichita County.

Brazos, 1808. See Red River.

BRENHAM.

Brenham Township, Kiowa County, Kansas.
Here also Haviland Township and Kiowa County.
Latitude 37° 38′ N., longitude 99° 5′ W.
Iron-stone, Pallasite (Pk) Krasnojarsk group of Brezina.
Found 1885 or 1886; described 1890.
Weight, over 900 kgs. (2,000 lbs.).

The first description of these meteorites was given by Kunz [1] as follows:

This interesting group of meteorites, numbering over 20 in all, weighing together about 2,000 pounds, and individually from 466 pounds down to 1 ounce, was found by farmers in Brenham Township, Kiowa County, Kansas, in the year 1885 or 1886. They were embedded to a slight depth in the soil, which here for about 100 feet deep is formed of Pleistocene marl, originally the bottom of an ancient lake; they occurred scattered over a surface more than a mile in length, principally, however, in a square of about 60 acres. On the high prairie not a stone of any kind is to be found; hence the ranch men and settlers were greatly surprised at finding heavy "rocks" or stones projecting through the prairie sod. The masses were nearly all found by being struck by mowing machines, ploughshares, corn cultivators, or other farm implements. For several years after they had been identified as meteorites they were used as weights to hold down haystacks, barrel covers, etc., until Mrs. Kimberly applied to Professor Cragin, of Washburne University. Professor Snow, of Lawrence, Kansas, visited Kiowa County several times, and the last time obtained the 101.5-pound mass in the streets of Greensburg, the county seat, where it had lain for several years in front of a lawyer's real estate office.

The exterior of all the masses shows the characteristic pitting. The surfaces have all been more or less oxidized by exposure to the elements, showing that the fall is not recent, and that the original mass was composed of crystalline iron as well as of iron filled with crystals of olivine; in other words, the masses show two distinct groups. Of these the 345-pound and the 75-pound masses are nickeliferous iron of highly octahedral structure and cleavage, and are medium octahedrites, while the others are meteoric iron containing olivine, and belong to the group known as pallasites.

The largest mass, a pallasite, weighed 466 pounds (211.818 kg.). It was thick, slightly flattened, triangular in form, somewhat heart shaped, and measured through the longest part, 61 cm.; across the widest part, 48 cm., and in the thickest part, 37 cm. It was covered with large indentations measuring 10 by 6 by 3 cm. The coating was more or less oxidized, but the olivine was more or less perceptible in all parts of the mass. The dimensions of the 345-pound mass were 60 by 37 by 29 cm. and it was slightly arched shaped. It was composed of iron with many pittings and showed the characteristic magnetic oxide of iron rust. The 219-pound mass measured 15 by 41 by 26 cm., and was shaped like a three-sided pyramid. The 211-pound mass was somewhat rounded, with a circular depression on one side. There were two masses weighing 125 pounds and 54.96 pounds, respectively. The 101.5-pound mass was almost round, measuring 35 by 26 by 27 cm. The exterior was evenly pitted, the center of each pitting being occupied by an olivine crystal. The 75-pound mass was an iron, and measured 32 by 22.5 by 15 cm., and was shaped like a pear or ham, and was covered with pittings. The crust had been changed somewhat by weathering. The 71.5-pound mass measured

27 by 23 by 22 cm., was jagged and irregular in shape, and showed olivine crystals all over the exterior. The 60-pound mass measured 36 by 21 by 17 cm. and was an elongated rounded piece, with one large flat side showing large spaces filled with olivine. The 40-pound mass measured 22 by 21 by 13 cm. It was of irregular shape with one large projecting point. The 36-pound mass measured 22 by 22 by 16 cm., it had the shape of a flattened spheroid, containing some olivine, but almost entirely iron, showing large pittings like the 75-pound or the 345-pound masses. There were 17 or 18 small masses weighing 18, 12, 7, 6, 5, 3, and 1 pound respectively; and a few weighing only 1 ounce each.

Analyses by L. G. Eakins:

Iron.		Olivine.		Outer olivine.	
Fe	88.49	SiO_2	40.70	SiO_2	34.14
Ni	10.35	Al_2O_3	Trace.	FeO	23.20
Co	.57	Fe_2O_3	.18	NiO	Trace.
Cu	.03	FeO	10.79	CoO	.03
P	.14	NiO	.02	MnO	.09
S	.08	MnO	.14	MgO	40.19
C	Trace.	MgO	48.02	S	5.42
Si	Trace.		99.85		103.07
	99.66			Less O for S	2.71
					100.36

Specific gravity, 5.17–7.15.

The iron is brilliant white, inclosing the troilite, and surrounding the olivine crystals. Occasionally small etched surfaces show delicate figures like the Linnville Mountain meteorite. Troilite exists plentifully in rounded grains from 1 to 5 mm. in diameter, and in thin folia mixed with and surrounding the olivine crystals, as well as running into and filling small spaces in the body of the iron, either as flat plates or rounded masses. Several flat circular plates (crystals?) of graphite, 2 mm. in diameter, were also observed. The olivine crystals are very brilliant and break out entire, the faces on many of them being distinct enough to allow measurement of the angles. The spaces from which they break are highly polished, showing every crystal face with mirrow-like luster; and in the center there is a coating of a shining mineral that is jet black in color, and crushes into a jet black powder. Many of the olivine crystals are in two distinct zones, the inner half a bright transparent yellow, the outer a dark-brown iron-olivine. In reality this dark zone is an intimate mixture of troilite and olivine.

This group of meteorites possesses more than ordinary interest on account of its peculiar composition and structure, and because of its probable connection with the meteoric iron found in the Turner Mounds in Ohio. It is probable that a small mass of 2 or 3 pounds was carried by the Indians to the Ohio valley (?). In both the Kiowa County and the Mound specimens the body of the meteorite is iron, in which are embedded circular masses of crystals of olivine.

Snow [2] described the find of an additional individual as follows:

Since my communication in Science of May 9, in reference to the Kiowa County (Kansas) meteorites, I have again visited the locality and obtained a 218.25-pound pallasite. This is not a new find, but is one which was first discovered upon the farm of Mr. James Evans more than a year ago. The location may be seen by consulting the map illustrating Mr. Kunz's article in Science of June 13. Only about 1 square foot of the surface of this meteorite, just level with the ground, was exposed to view, and it thus easily escaped subsequent observation on the unploughed grassy prairie. The dimensions are 20.5 by 16.5 inches, by 10.5 inches at base. The shape is that of an irregular triangular pyramid, and it stands easily upon its base. The specimen, not having been exposed to the weather and the dangers of rough usage, as were the other members of this group, presents fine clusters of olivine crystals in several cavities upon two of its faces. There are eight cavities on one face. Some of the cavities are 4 inches in diameter and 2 inches deep. Nearly all the cavities contain fine crystals of yellow olivine and of chromite. Some of the former are three-sixteenths of an inch in diameter, and so perfect that the angles can readily be measured. This specimen is also unique in that the crystals of chromite are so large and so prominent. The chromite has a fine luster, gives a dark-brown powder, and scratches glass.

Much of the olivine is black and glassy, with a conchoidal fracture. It shades imperceptibly into a honey-yellow and colorless varieties. The light yields a light-brown powder, and is very brittle. Its fusibility is about five.

At some points on the surface there is a dirty white incrustation. This, on examination, proved to be carbonate of lime, and is without doubt due to deposits from the calcareous soil in which the meteorite was embedded.

The prevailing color of this iron is dark reddish brown, more inclined to red than others of this fall that we have seen.

On cutting a section from the meteorite and treating the polished surface with nitric acid, the characteristic Wiedmannstätten markings are visible. The fragments of troilite can be plainly seen on the polished surface. The meteorite has about the same arrangement of iron, olivine, etc., as others of this group. Its specific gravity, as obtained from the whole mass, is 4.79; that of the iron and nickel alloy is 7.70; of the olivine (yellow), 3.64 (water at 25° C.). The volume of the entire mass, determined in the process of obtaining its specific gravity, was found to be 20.6 liters.

Winchell and Dodge [3] also examined and described some individuals, their account being in part as follows:

A polished section of the 221-pound mass shows metallic iron as composing somewhat less than one-half the entire surface and serves as a matrix in which are embedded amygdaloidal or roundish masses from the size of a pea to that of a musket ball, and larger, of the black and yellowish minerals which comprise nearly the whole of the rest of the mass. The iron framework of the whole mass is not regularly cellular, but with many partings and tortuous shapes it fits closely about the concavities in which the minerals lie and gives firmness and shape to the whole.

The Widmannstätten figures were brought out on this surface by etching. Some of the metallic iron does not exhibit the characteristic bars, and generally there is a narrow marginal strip on all these surfaces that does not show them.

Analysis of metallic portion:

	Per cent.
Fe	90.48
Ni	8.59
Co	.16
Cu	Trace.
P	.27
S	.05
C	Trace.
Silica	.24
Chromic oxide	.09
	99.88

Analysis of light colored nonmetallic portion:

Silica	40.50
Ferrous oxide	10.51
Ferric oxide	1.77
Magnesia	47.18
Phosphorus	Trace.
	99.96

Analysis of dark colored nonmetallic portion:

Silica	25.88	
Ferrous oxide (part)	7.53	Containing iron, 5.86
Magnesia	31.95	
Chromic oxide	12.28	Containing iron, 6.34
Ferrous oxide (part) by formula $FeO.Cr_2O_3$	5.82	Containing iron, 4.53
Ferric oxide (part)	.21	Containing iron, .15
Sulphur	1.73	
Iron combined with sulphur, by formula FeS	3.03	Containing iron, 3.03
Nickel	.65	
Phosphorus	.18	
Iron combined with phosphorus and nickel, Ni_2Fe_4P	1.30	Containing iron, 1.30
	99.62	Total iron, 21.21

But three minerals were detected in this meteorite by microscopic examination of thin sections, viz, olivine, chromite, and troilite.

The results differ somewhat from those of Kunz and the authors say:

Whereas the analyses given by Kunz show the presence of a small amount of manganese oxide and ours show none, our analyses indicate the presence of a considerable amount of chromium, and his show none.

They also found the olivine masses in rounded forms, embraced in brilliantly lined cavities within the metallic iron, but they did not distinguish any individual crystal faces nor exterior angles.

The probable relations of the Kiowa County meteorites to the meteoric material found in the Turner Mound, Ohio, were discussed by Huntington [4] with the conclusion that there was no proof that the two were identical.

In 1892 Hay [5] reported the finding of additional individuals as follows:

This spring some more meteorites were found, which extend the area of the find as described by Kunz, Snow, and Winchell nearly a mile farther east and increase the number of meteorites several thousand. One mass of 80 pounds has been obtained, but the rest of the find represents a new feature in the remarkable fall. There has been one distinct

meteorite of 19 ounces in weight besides the large one, but the rest were found in groups of small meteorites from about a pound in weight to the size of a pea. Each group was scattered over an area of 15 to 30 square yards. The larger individuals of the groups show themselves true pallasites and even some very small ones, but many of these latter are largely oxidized, the metallic iron having all disappeared. All stages of oxidation are shown in each group. The large mass and three groups—the smallest weighing 3 pounds and numbering 400 individuals—are in possession of the writer, at Junction City, Kans.

Meunier [6] gives the following account of a study of the structure of the meteorites:

The Kiowa meteorites have been studied by several American scientists such as Snow, Huntington, and Kunz, who published the analysis by Eakins and Hay. But their geological history has hitherto been neglected.

It is to be noted first that different mineralogists are far from being unanimous in their determinations, these divergences being due in part at least to the fact that their specimens were not identical. In order to get an adequate idea of the Kiowa meteorites it is essential to use enough specimens to show the variations of which the fall is susceptible.

Within limited areas massive blocks of iron, without any admixture of stony matter, have been recognized, while other portions are of a spongy nature with the cavities in the iron filled up with stony matter. In the latter instance the meteorite resembles the celebrated Pallas iron; so that several authors have included the American specimens in the type pallasite of Rose. This conclusion appears to be erroneous.

The metallic portion presents two principal alloys of iron and nickel, that is, tænite (Fe_8Ni) and plessite ($Fe_{10}Ni$). In this respect Kiowa differs from the pallasite variety whose metallic network is composed of tænite and kamacite; it was on this account that Kunz wrongly called this metal caillite. According to its composition, it coincides with a wholly metallic type of meteorite which since 1870 I have designated as jewellite.

Nevertheless the structure of the metallic part is not that of jewellite, the difference being due to special lithogenic conditions. Apart from the peridotic particles, the mass is formed of laminæ of tænite arranged in bundles which intersect under the angles of the octahedron. The spaces between the laminæ are filled with plessite, which is distinguished at first sight by its color, which is a very dark gray, contrasting with the appearance of polished steel in the case of the other alloy. Frequently the plessite forms little isolated specks of a fusiform outline or more or less circular or entirely irregular, bordered by more or less extended laminæ of tænite, a condition not noticed in any other meteoric iron.

In proximity to the grains of peridote, the relation of the two alloys frequently takes on another character and, although the Kiowa meteorite does not present in the same degree the concretionary and concentric character of the pallasite, one frequently notes an evident enveloping of the silicate grains with nickel-iron. It is then the plessite which is in contact with the stony mineral; it constitutes a zone frequently very thick and whose exterior outline is not then in the least parallel to the profile of the peridote. In more than one place several grains of olivine are enveloped in the same mass of plessite, which may at the same time contain different nodules. These latter are usually of pyrrhotine, in small amounts, and of schreibersite, which on the contrary is present in large amounts. Sometimes it is composed of true nodules measuring possibly 1 cm. in diameter, sometimes it forms a kind of coating around the peridote or around the small masses of sulphide. It is of a tin-white color, slightly yellowish, very fragile, insoluble in chlorhydric acid, and very strongly magnetic.

The silicate portion of the Kiowa meteorite is formed entirely of olivine, which affords the closest analogy with that of Pallas. It does not form true crystals in any part, but cleavage fragments much rounded and covered with metal.

In thin sections, under the microscope, this peridote presents numerous cleavages, many of which are as it were injected with matter entirely opaque, which pass insensibly into zones with which the mineral is traversed. These latter frequently contain opaque inclusions, where may be seen, under strong magnifying power, the outlines of octahedral forms. Huntington found chrome iron, but the most searching study fails to show any magnetite. The yellowish zones and the inclusions they contain proceed without doubt from a peculiar alteration of olivine. There may be found near them portions limited by the cleavage and which are evidently serpentinous.

Some specimens of this meteorite are very exceptional in character. With the usual structure and cohesion, they show forms of blackish and opaque mineral grains cemented together by a network of oxidized iron. A glance suffices to show that they result from an alteration of normal specimens. The metallic skeleton has been oxidized and the peridotes radically changed. Analysis shows the ferruginous oxide to be magnetite. This constitutes almost the entire network between the silicates and the loose filaments in the fissures of the peridotes. I reproduced by heating to redness in the vapor of water a fragment of the Kiowa meteorite, with all its characteristics.

Strictly speaking, one would suppose that the heating necessary to generate magnetite would date from the passage of the cosmical mass through our atmosphere, but it is clear that the vapor of water would not, at this moment, intervene in sufficient quantity. It is therefore necessary to conclude that the oxidation took place in the meteoric medium itself, where jets of vapor analogous to our terrestrial steam volcanoes act upon the metallic rock previously constituted and heated to redness.

In the Paris catalogue a further description [7] is given which in part repeats the previous observations and in part adds to them. It is as follows:

The Paris museum contains, besides other specimens, a fine polished sample of more than 1 kg. weight of the Kiowa meteorite.

As to its mineralogical composition, the metallic portion agrees with jewellite, and yet it is distinguished by its structure by reason, doubtless, of special lithogenic conditions. Instead of peridotic particles the mass is formed of laminæ of tænite arranged in bundles which intersect at angles corresponding to those of the octahedron; the interspaces between the laminæ are filled with plessite, which is distinguished by its very dark gray color, contrasting with the polished steel shade of the other alloy. Frequently the plessite forms spots with fusiform or more or less circular outlines, or quite irregular, with a border of tænite more or less continuous, a condition which has not been noted in any other meteoric iron. Near the grains of peridote the relation of the two alloys frequently takes on another character, and although the Kiowa meteorite does not present the same degree of concretionary and concentric structure as the pallasites, nevertheless the silicate grains are frequently observed to be covered with the nickel-iron. It is then the plessite which is in contact with the stony mineral; it frequently constitutes a very wide zone and its exterior outline is not then in the least parallel to the profile of the peridote. At more than one point several grains of olivine are enveloped with the same border of plessite, which may at the same time contain different nodules. These latter ordinarily consist of pyrrhotine, in small quantities, and of schreibersite, which, on the contrary, is quite abundant. Sometimes this phosphuret constitutes the true nodules, as much as 1 cm. in diameter; sometimes it forms a sort of covering around the peridotes or around small masses of sulphur. The schreibersite is of a slightly yellowish tin-white color, very fragile, insoluble in hydrochloric acid, and strongly magnetic.

The silicate portion is formed exclusively of olivine, which affords a complete analogy with the lithosiderite of Pallas. It does not form true crystals at any point, but much rounded cleavage fragments completely covered with metal. It is easy to dislodge the grains under consideration, with a steel point, from the cells which contain them and to take the impression of the latter with wax; it is then easy to recognize fragments originally angular which have been more or less corroded by the agents to which is due the concretion of the metallic portion.

In thin sections under the microscope the peridote presents very numerous cleavages, many of which are nearly filled with a perfectly opaque material which passes insensibly into the ocherous zones with which the mineral is traversed. These zones frequently present opaque inclusions in which may be seen, with a strong magnifying power, the indications of octahedral forms. Huntington noted the presence of chromic iron in this, but an attentive study failed to reveal either oxide of iron or magnetite. The yellowish zones and the inclusions which they contain certainly proceed from a particular alteration of the olivine; there is also found in their vicinity portions limited by the cleavages, and which evidently consist of a serpentine material.

Several specimens of the Kiowa meteorite have a very exceptional character. From their structure and natural cohesion they prove themselves to be formed of black opaque mineral grains cemented together by a network of oxide of iron. A glance shows that they are the result of an alteration of normal specimens; the metallic skeletons have become oxidized and the peridotes are greatly changed. However, it does not resemble a simple attack of the elements; analysis shows that the ferruginous oxide which predominates in it is neither limonite nor gœthite, but magnetite. It is this which constitutes nearly the whole network between the silicate grains and the filaments liberated in the tissues of the peridotes.

Brezina's account of the characters of the meteorite is given in the Vienna Catalogue for 1895,[8] and is as follows:

Brenham is a highly characteristic pallasite. Among the numerous large individuals some are free from olivine and can be placed with the unit oriented octahedrites. Others are in part free from olivine and in part olivine-bearing pallasites, with unit orientation of the nickel-iron. Finally a third class and pieces with intimate mixtures of siliceous and iron particles having a size of grains up to 5 or 6 cm., show the iron portion not oriented as a unit. This reminds one of Netschævo, in which I observed at times an intimate mixture of metallic with the stony constituents, likewise a unit orientation of the iron. Most pieces of this pallasite seem to have suffered pretty strong oxidation. The olivine in the peripheral parts has become abundantly turbid and is penetrated by opaque veins. The kamacite in such places is altered to an opaque limonitic substance, while the plessite in part and the troilite and schreibersite almost altogether remain unchanged. A plate cut from the middle of an individual weighing 36 kg. shows on the etched surface large, round olivine crystals reaching 2 cm. in diameter, now single, now more or less associated, surrounded by swathing kamacite 1 to 1.5 mm. thick, the intervening fields filled by now unit oriented in the greater portion and now varying oriented trias in which fine tænite-rich bands stand in equal proportion with a now purely plessitic and now half hatched skeleton filling. Between the olivine and swathing kamacite, schreibersite and troilite are abundantly included, often as simultaneous successors of the olivine and often lying beside one another about the same olivine grain, the succession being olivine, schreibersite, troilite, swathing kamacite, and trias. Loose olivine shows plane bounding faces as well as round fusion forms. The latter, though, are almost never lacking and exceed the former. Among the many thousands of the olivines which have been exposed by numerous sections of Brenham I have found only one which was completely bounded crystalographically and this shows weak rounding of the edges. Besides the large individuals there were found distributed portions of 500 or 600 little individuals which originated from a larger piece by alteration. Two such specimens weighing 3.3 and 6.3 kg. are at hand; the first cleansed by washing, the latter in the unchanged altered condition. They show the manner of alteration of such masses, the single constituents suffering a higher or lower degree of oxidation.

The meteorite is quite generally distributed.

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BRIDGEWATER.

Burke County, North Carolina.
Here also Burke County, 1890.
Latitude 35° 41′ N., longitude 81° 45′ W.
Iron. Fine octahedrite (Of) of Brezina.
Found and described 1890.
Weight, 13.15 kgs., (29 lbs.).

This meteorite was first described by Kunz[1] as follows:

This meteorite was found by a negro plowman, 2 miles from Bridgewater station, in the western part of Burke County, near the McDowell County line in North Carolina, latitude 35° 41′ N., longitude 81° 45′ W., of Greenwich, in the year 1890. The negro thought that it must be either gold or silver from its weight, and took it to some railroad laborers, who broke it into two pieces, one of which weighed 10.5 pounds and the other 18.5 pounds, or 30 pounds in all. The mass measured 22.5 by 15 by 10 cm. (9 by 6 by 4 in.).

Traces of black crust very much oxidized are still visible on the surface. The iron is octahedral in structure, so that the mass was readily broken by the laborers who found it. Between the cleavage plates schreibersite is visible. On etching a polished surface of this iron the characteristic Widmannstätten figures are brought out.

The specific gravity of a fragment was found to be 6.617. The following analysis was kindly furnished by Prof. F. P. Venable, of the University of North Carolina:

Fe	Ni	Co	P	Cl	
88.90	9.94	0.76	0.35	0.02	=99.97

Kunz gives a cut of the mass and its etching figures.

Brezina[4] notes—

the presence of deep clefts following the octahedral structure. It was along one of these clefts that the mass was broken by the laborers. The surface of one such cleft follows an octahedral face 9 cm. long and 7 cm. broad and cuts through a series of octahedral steps for 7 cm. into another octahedral surface. An etched surface shows uniform structure with long, straight, little bunched bands. The kamacite has fine, half-shaded hatching of a peculiar flakiness resulting from the unequal etching of single portions of each band. Tænite is strongly developed. The fields are small, filled chiefly with gray plessite, rarely with shadowy lamellæ. Streaks of cohenite occur occasionally though not abundantly in the kamacite; also rarely schreibersite with outlines suggesting crystal form and containing spherical troilite inclusions.

Cohen[3] found the iron capable of acquiring more or less permanent mangetism, and Leick[2] found that it possessed a specific magnetism of 2.63 units per gram.

Cohen[5] further describes the structure of the iron as follows:

Bridgewater is distinguished by long, straight, swollen, rarely and only weakly grouped lamellæ, very prominent tænite, and not large but richly distributed fields which nearly equal the lamellæ in quantity. The kamacite is generally not at all granulated, but in places weakly so. It is strongly hatched. On the majority of the bands ridges appear prominently accompanied by sparing and very small etch pits, and the oriented sheen is strong. Other bands have a flaky appearance and duller luster. Ridges do not appear on strong magnification, but the main mass of the kamacite is much darkened, whether by angular, closely grouped pits or by embedded dust-like forms, can not be distinguished. The smaller fields and those lying between bands consist of compact dark plessite which, as usual under the microscope, appears to be uniformly filled with angular shining scales. In the more extended fields the latter are somewhat larger and in places so increase in number that it appears as if one such field was composed of small partly bright and partly

dark bands arranged according to octahedral faces. Under the microscope, however, these apparent bands do not appear to be sharply separated from one another and pass gradually into compact dull plessite. These are doubtless Brezina's "shadowy lamellæ." As accessory constituents the piece which I investigated contains grains of iron glass near the natural surface and some schreibersite-like elongated crystals embedded in kamacite. The iron rusts easily from the oozing of drops of iron chloride.

The iron is distributed, the Vienna collection possessing 8.5 kg.

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Buncombe County, 1835. See Black Mountain.
Buncombe County, 1839. See Asheville.
Burke County, 1882. See Linville.
Burke County, 1890. See Bridgewater.

BURLINGTON.

Otsego County, New York.
Here also Cooperstown 1819 and Otsego County.
Latitude 42° 42′ N., longitude 75° 12′ W.
Iron. Medium octahedrite (Om) of Brezina; Burlingtonite (type 17) of Meunier.
Found before 1819; described 1844.
Weight, 50 to 100 kgs., "100 to 200 pounds."

The history and characters of this meteorite were first given by Silliman [1] as follows:

Dr. L. C. Beck, in his report on the mineralogical survey of New York, p. 383, makes mention of a mass of malleable iron, said to be native, which he saw in the cabinet of the Albany Institute. It does not appear that any chemical examination was made of the mass.

Last November Mr. E. C. Herrick, being in Geneva, New York, received from the hands of Prof. James Hadley of that place a mass of metallic iron, which Professor Hadley assured him was a portion of the same specimen mentioned by Professor Beck in his report above quoted, and that both belonged to a larger mass, which when found was supposed to weigh from 100 to 200 pounds avoirdupois. Mr. Herrick also learned that Dr. Eli Pierce of Athens, New York, was the gentleman who originally communicated the specimens and information to Dr. Hadley.

On Mr. Herrick's return to this place, the mass was placed in my hands for examination. Its strong resemblance to the iron found in North Carolina by Professor Olmsted, and examined subsequently by Professor Shepard, immediately struck me; it was divided by broad laminæ, crossing each other at angles of 60° and 120°, cutting up the surfaces into triangular and rhombohedral figures. It broke with a hackly fracture and only with the greatest difficulty on the thinnest edges.

Two deep and broad sutures marked its two most regular and opposite faces, made by the wedge or chisel by which the blacksmith (into whose hands the larger mass unfortunately came) severed it from the adjoining portion. It bore the marks of having been intensely heated at the smith's forge, and numerous microscopic crystals of a black color and brilliant luster covered some parts of its surface. They resembled phosphate of iron, but were too small to be detached. I had no doubt on first seeing the mass of its extra-terrestrial origin, which opinion was confirmed by the following analysis performed in my laboratory by Mr. C. H. Rockwell, one of my pupils.

It dissolved quickly and completely in pure nitric acid, with the application of a gentle heat. The solution tested with nitrate of silver gave no cloudiness, showing the absence of chlorine. Still further to settle the question of the presence of chlorine, the mass was put in a clean capsule and placed over a water bath, covered on the plate of an air pump by an air-tight jar. After exposure to this humid atmosphere for a week it was taken out and washed with pure water into the capsule, which contained also water of condensation from the mass. These washings, tested with nitrate of silver, remained quite unclouded. After the heat to which the mass has been subjected in the smith's forge, it could hardly be expected that we should find any traces of chlorine, if it ever existed. The solution of the iron in nitric acid yielded with the usual process for separating iron from nickel—

Metallic iron	92.291
Metallic nickel	8.146
	100.437

No traces of other substance could be detected in the iron. Specific gravity, 7.501.

With a view to obtain all the information possible in relation to this interesting meteoric iron, Mr. Herrick addressed a letter of inquiry to Dr. Pierce, which brought the following particulars. He says: "In the year 1819, I procured some two or three masses of native iron (as it appeared to be) from the farmer who first turned it over with his plow in a field near the north line of the town of Burlington, Otsego County, New York. These consisted of remnants of an entire mass originally supposed to weigh between 100 and 200 pounds and found several years before. Before I had any knowledge of its existence, it had been in the forge of a country blacksmith and the whole heated in order to enable him to cut off portions for the manufacture of such articles as the farmer most needed. The smith assured me that he had never worked stronger, tougher, or purer iron; that it made the best horseshoe nails. All the fragments that remained I immediately secured, and presented them to Professor Hadley, whose lectures I was then attending. These were in two or three irregular masses, in all some 8 to 12 pounds, with the marks of the chisel used in cutting while in a heated state. In conversation with the farmer who found the original mass, I could only learn that in plowing the field he found a stone, very heavy, rusty on the top, which lay above the surface. From its great specific gravity he was induced to examine it more particularly, and thinking it might be iron he carried it to his blacksmith, who, finding it iron, had worked up the most of it into horseshoe nails, etc., as the farmer needed. The latter told me that he had seen several small specimens of what appeared to be similar whilst plowing the same field, but a diligent search made by me at the time proved fruitless in discovering any other specimens, the field being at that time in meadow.

"It was the opinion of Professor Hadley, on the first examination, that it was of meteoric origin. Why it was not completely buried in falling may be accounted for by the fact that the ground on which it was found was hard and strong."

Measures have been taken to secure as much of this interesting mass as can now be obtained for the mineralogical collection in Yale College.

Further description was given later by Shepard [3] as follows:

This mass (originally 150 pounds in weight) was described by Professor Silliman, jr. It was ploughed up by a farmer, near the north line of the town, sometime prior to 1819. Portions were cut from it, from time to time, by the discoverer's blacksmith for agricultural uses, until its weight was diminished to about a dozen pounds, when it fortunately fell into the hands of Professor Hadley of Geneva, New York, to whom I am indebted for a conical lump weighing 9 pounds, which must have formed a somewhat pointed extremity of the original mass. From the base of this a slice was taken, leaving a lump of five pounds of the annexed form. Its sides show, for the most part, the natural crust of the iron, but where this is not the case the surface has been cut and polished, or is coarsely crystalline with large tetrahedral and subhackley faces, occasioned by the breaking off of what was apparently projecting prongs. Its polished faces show a very high luster, with a color of nearly the same whiteness as German silver. Held at a proper angle, they discover very distinctly the same crystalline characters which are still more distinctly brought out by the action of acids. The etched surface is illustrated by the accompanying figure. The pattern is strikingly peculiar, as well as beautiful. The bright shining veins, which resist the action of the acid, are rarely nearer together than $\frac{1}{15}$ or $\frac{1}{20}$ of an inch, and these in place of being continuous are interrupted at frequent intervals. In their course also, they frequently exhibit little triangular enlargements, the sides of the triangles curving inward. The surface included between the shining lines and which forms at least nine-tenths of the whole, is everywhere finely freckled, as if depending upon granular texture and even bears some analogy to what is familiarly known as crystallized tin, or *Moiree metallique*.

Its hardness is very unusual, no iron with which I am acquainted offering on the whole so much resistance to the operation of slitting. Mr. Rockwell gives as its composition, iron 92.291, and nickel 8.146. My own result in a single analysis is as follows:

Iron	95.200
Nickel	2.125
Insoluble	.500
Sulphur and loss	2.175
	100.000

Clark [4] obtained the following composition by analysis:

Fe	Ni	X	S and loss	
89.752	8.897	0.625	0.703	=99.977

He also found traces of copper and manganese; the first may have come from the tools with which the chip was obtained.

Shepard [6] states that "in cutting a slice from the iron a single, very symmetrical, drop-shaped cavity more than half an inch in diameter was disclosed which communicated by a minute opening with the surface. Its walls are almost perfectly smooth and coated by a brownish-black powder, not yet examined."

Reichenbach [9] noted the presence of cylindrical or elongated cone-shaped masses in this iron. He compared their form to that of belemnites or to the filling of auger holes and states that they often lie close together in parallel arrangement and in large numbers.

Brezina [16] in 1885 groups Burlington with Trenton. He gives the width of the lamellæ as 1.2 mm. and states that they are strongly swollen.

Meunier [17] describes Burlington as a very peculiar iron which yields singular etching figures. The tænite lies in a mass composed principally of braunine, in singularly irregular patches. The crevices are filled with a carboniferous black substance. Braunine includes fine specks of schreibersite. On dissolving in chlorhydric acid the iron gives off a noticeable odor of hydrogen sulphide.

Brezina [18] in 1895 says:

A piece cut from the end shows the natural surface to be composed of angular, octahedral planes; upon the section surface are seen not very straight, somewhat grouped, very puffy bands with well-developed tænite. The fields are inconspicuous, plessite more noticeable; kamacite and plessite conspicuously spotted.

The meteorite is distributed, Wülfing listing 4867 grams. Washington possesses 1,528 grams and New Haven 738 grams.

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Butcher Iron. See Coahuila.

BUTLER.

Bates County, Missouri.
Here also Bates County.
Latitude 38° 15′ N., longitude 94° 18′ W.
Iron. Finest octahedrite (Off) of Brezina; Jeknite (type 11) of Meunier.
Found 1874; described 1875.
Weight, 36 kgs. (80 lbs.).

This iron meteorite is described by Broadhead [1] as "ploughed up in a field by a man named Abram Crabbe, living 8 miles southwest of Butler, Bates County, Missouri. For a long time it remained scarcely noticed by the finder, but at last, thinking it rather heavy, he brought it into Butler and left it at a blacksmith shop.

Its total weight was a little less than 90 pounds, and it was a rough looking, rather irregular mass, somewhat pitted over the surface.

The surface had a thick coat of rust, the metal was very tough, and in section showed numerous nodules of troilite free from any schreibersite. The Widmannstätten figures were easily developed, and were large and regular.

Smith [2] gave the following analysis:

Fe	Ni	Co	Cu	P	
89.12	10.02	0.26	0.01	0.12	=99.53

Specific gravity, 7.72.

Brezina[3],[4] gave a detailed account of the structure of this iron as follows:

A fragment weighing 1 kg., 334 grams, has three etched section surfaces almost perpendicular to one another and one unetched section surface parallel to one of the former; as for the rest, the fragment is bounded by the natural outer surface, which is constituted like all meteorites which have lain for a long time in the ground.

Upon the etched surface it appears above all that the principal part of the iron has an apparently perfectly compact structure; in this ground of a lusterless iron-gray color lie numerous lamellæ, sometimes entirely individual, sometimes massed together in juxtaposition but not heaped up like scales, upon each section of which appear four differently arranged systems; these lamellæ taken together form a framework, and indeed, an octahedral framework exactly as indicated (by Tschermak) for an hexahedral form. The groundmass is entirely lusterless and structureless; a peculiar shimmering appearance of the same is produced by inclusions to be mentioned later on; the hardness of the groundmass is unusually low, something under 4, which is easily scratched by fluorite, and by scratching with a steel needle the difference in the same respect is likewise ascertainable. The systems of lamellæ are composed of a very fine central portion, which on account of its gray color, its hardness (4, only slightly higher than that of the groundmass), and its lack of structure, possesses the greatest similarity with the groundmass; only in a few broader places does a faintly indicated granular structure of the central part of the lamellæ show itself, but without hatching, which reminds one of the condition of the kamacite in other meteorites. The envelopes of the lamellæ are composed of tænite, which, on account of its bright luster after etching and the faint yellowish color thereby acquired, is easily recognizable.

The width of the lamellæ is very slight, the central part with both envelopes being in the greater number of cases scarcely more than the sixtieth of a millimeter; the length of a lamella is commonly 15 or 20 mm., although it reaches even 30 mm. and over. Where differently arranged lamellæ touch one another the one system is for the most part developed entirely undisturbed—its earlier origin identified, whilst the other arises thereon with core and envelope immediately adjacent to the envelope of the first; occasionally, although seldom, they are arranged core to core and envelope to envelope, as proof of the synchronous origin of both systems from the point of common contact. Among the principal framework of the four systems of lamellæ, as is customary in the case of skeleton-like structure of crystals, are found irregularly oriented little leaflets, many of them arranged parallel to each other, but some also crosswise; along with these lie very short lamellæ, and even small—1 to 2 mm. long—veinlets in the groundmass, which, grading down to microscopic smallness, occasion the shimmering appearance of the groundmass.

Besides these principal constituents troilite occurs in roundish, lenticular masses, measuring up to 2 cm. in diameter, which are present in large numbers down to the smallest granules; the larger among them have an envelope of tænite which follows their often somewhat jagged contours, and around this is a second envelope equalizing these unevennesses of gray, structureless iron, similar to the groundmass and yet somewhat different from it, entirely analogous to the condition of such inclusions in many other meteorites; the lamellar system contains no troilite, which was shown by treatment with hydrochloric acid.

The greatest section surface does not depart so widely (some 13°) from the position of a leucitohedron face; three distinct lamellar systems cross one another at angles of 70°, 61°, and 49° thereon, the fourth is veinlike and broadened. It intersects—as the other section surfaces show—at a very obtuse angle and makes a perpendicular in the triangle formed by the other three, dividing the angle of 61° into two of 44° and 17°, so that the greater angle adjoins that of 49°. The adjoining angles in order are—

$$70°, 17°, 44°, 49° \ (17°+44°=61°)$$

Brezina [4] also uses several etchings of this iron to illustrate his method of determining the crystallographic character of a meteoric iron from the Widmannstätten figures, and to prove that the figures in question arise from laminæ parallel to the faces of an octahedron.

Huntington [7] describes the structure as follows:

The Widmannstätten figures are very fine and not in broad, distinct plates, while some of them are even microscopic; and yet from this iron was obtained a far more perfect octahedron than from any of those with a coarser structure. On etching the faces of such an octahedron it appeared that the majority of the plates, including even the finest microscopic markings, followed the direction of the octahedral faces; but certain plates bisect the facial angle of the octahedron. These plates, when followed over an edge on to an adjacent face, were seen to be parallel to an octahedral edge, showing that they must be dodecahedral instead of octahedral.

Thus it appears that the Widmannstätten figures are not solely characteristic of octahedral structure. Furthermore, the Butler meteorite seemed to stand between well-marked Widmannstätten figures and the finer lines discovered by Neumann and shown by him to be parallel to cube edges. Some of the Butler figures are coarse enough to be classed unquestionably as Widmannstätten figures; that is, they show the three varieties of iron distinguished by Reichenbach, which he calls the Trias (kamacite, tænite, and plessite); while others of the figures are almost microscopic markings in which distinct plates of kamacite and plessite can not be made out even under the microscope. Between these two extremes there is every gradation. The Butler meteorite has always been classed among the octahedral irons.

Meunier[9] gives the following description:

A very remarkable iron in that plessite forms almost the entire substance. The extremely thin tænite laminæ are very long and are ordinarily grouped in bundles which may be separated under the glass. Solution of the iron gives a carbon precipitate and the odor of hydrogen sulphide.

Cohen[13] sums up the results of his own investigations as follows:

A dull and compact iron of low hardness, 3–4, forms a strongly predominant groundmass which receives a peculiar shimmering appearance from numerous minute shining flakes. In these lie numerous long and very fine lamellæ, partly isolated and partly in bundles, generally unequally grouped but not gathered in zones. These consist of a nucleus of spotted, weakly granular kamacite with well-marked wrapping of tænite. In the latter, which, on account of its growth can by strong magnification be investigated here better than usually, there appear to be thin systems of lines resembling the striæ of kamacite. The lamellæ reach a length of 2.5 cm. and a thickness of about 0.05 mm., though on the one hand the latter become of microscopic dimensions and on the other hand show five faces. They are sharply separated from one another. At times, though, the nucleus and tænite border grade into one another, proving a simultaneous origin. Where the lamellæ intersect, which is not often the case, there are dislocations showing that part of the bands are somewhat older. Skeletonlike growths are abundant without becoming actual combs. Troilite is abundantly present, in part as rounded to lenslike nodules reaching 2 cm. in diameter and in part as minute spherules. The large nodules are commonly bounded by complete lamellæ (kamacite with tænite border on both sides—Brezina's swathing bands), which are somewhat broader than the octahedral lamellæ. The tænite generally projects in a ragged fashion, and that bordering the troilite is somewhat stronger than that lying outside. These large nodules have often served as nuclei for the growth of band systems which are, as a rule, especially strongly grouped. The lamellæ appear to be outgrowths of the swathing bands in which the kamacite nuclei were crowded against one another, while the tænite was fused; so that a tænite band commonly incloses both formations. The greater age of the troilite is shown by the fact that at one place the lamellæ turn aside from a nodule. Schreibersite in quantity and size is subordinate. Butler, in consequence of the strongly predominant plessite and the isolated position of the lamellæ through simultaneous formation, is well adapted to the study of skeleton growths as well as the grouping and displacing of lamellæ. The homogeneity of the troilite is also remarkable, since the usual abundant intergrowths of schreibersite and troilite are lacking. Leick found Butler acquired strong permanent magnetism. The specific magnetism he found to be 6.25 absolute units per gram, which is considerably higher than that of most other iron meteorites. The specific gravity at 21.9 centigrade was 7.8865.

The meteorite is distributed, the Harvard collection having the principal mass (14 kgs.).

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Cabarras County. See Flows.

CABIN CREEK.

Johnson County, Arkansas.
Here also Johnson County.
Latitude 35° 24′ N., longitude 93° 22′ W.
Iron. Medium octahedrite (Om) of Brezina.
Fell 3.17 p. m., March 27, 1886; described 1887.
Weight, 47.4 kg. (107 lbs).

This meteorite was first described by Kunz[1] as follows:

This mass fell about 6 miles east of Cabin Creek, Johnson County, Arkansas, in longitude 93° 17′ W., latitude 35° 24′ N., within 75 yards of the house of Christopher C. Shandy. Mrs. Shandy states that about 3 o'clock (3.17 p. m., exactly) on the afternoon of March 27, 1886, while in her house she heard a very loud report, which caused the dishes in the closet to rattle and which she described as louder than any thunder she had ever heard. At first she thought it was caused by a bombshell, and ran out of the house in time to see the limbs fall from the top of a tall pine tree, which she says stands about 75 yards from her dwelling. She did not investigate the matter until her husband came home about 6 o'clock in the evening, when in company with John R. Norton, their hired man, they went out to find the cause of the noise that had so startled Mrs. Shandy. They discovered that a large hole had been made in the ground by some falling body, and that the fresh dirt had been thrown up to a height of 30 feet on the surrounding saplings and trees. They dug down, and a steam or exhalation arose, which on a dark night might perhaps have produced a phosphorescence similar to that described in the case of the Mazapil iron. The iron had buried itself in the ground to the depth of 3 feet, and the earth around it for the thickness of 1 inch seemed to be burned.

The ground was still warm when the iron was taken out, and the iron itself was as hot as the men could well handle. The weather had been quite cloudy all day but no rain fell until night. These facts are from the affidavits of Mr. and Mrs. Shandy and John R. Norton. Mr. Shandy at first supposed that their find was platinum, then silver, and finally learning what it was he sold it. Mrs. India Ford, Dr. W. J. Bleck, Mr. S. A. Wright, constable, and Mr. L. Wright, chief of police, also heard the report caused by the fall.

The noise was heard 75 miles away and was likened to a loud report followed by a hissing sound as if hot metal had come in contact with water. It caused a general alarm among the people and teams of horses 25 miles distant, becoming frightened, broke loose and ran away; and in Webb City, Franklin County, on the south side of the Arkansas River, a number of bells, kept on sale in a store, are said to have been caused to tinkle. Cabin Creek is on the north side of the Arkansas River.

Mr. B. Caraway states that he heard two loud reports at Alma, Crawford County, at 3 o'clock on March 27, 1886. The report was also heard at Russellville and in the adjoining county of Pope. The Democrat of that place, says, April 29, 1886: "The wonderful meteoric stone as it is called, but erroneously, for nothing could be further from stone than it is, is now on exhibition here. The noise it made when it struck the earth's atmosphere on the 27th of March and came whizzing to earth near Knoxville, will never be forgotten, neither will anyone who looked at it ever forget it." The Dardanelle Post of April 1, refers to the explosion, and the issue of April 8 suggests the meteorite found as its probable cause. Mr. B. Caraway, who visited the spot, states that the pine through which the meteorite fell is 107 feet high, and that the distance from the foot of the tree to the center of the hole made by the mass is 22 feet 3 inches. The limbs on the west side of the tree were broken and the meteorite lay in the hole with the flat side down. The hole was 75 yards from the house.

Prof. H. A. Newton states that the data furnished indicate that the mass must have fallen nearly from the zenith. This was the direction of the end of its path, the earlier portion being more inclined to the vertical, as the path must be affected by gravity and the resistance of the air. The earlier direction must have been from the northeast and more nearly from the east than from the north.

After passing through several hands, it was exhibited for profit as "the tenth wonder," although the exhibitors were not aware of the fact that this was (probably) the actual tenth iron which has been seen to fall.

The mass is in general quite flat and very irregular, resembling strongly a mass of molten metal thrown on the ground and then pitted. The illustration of the Agram mass figured by Von Schreibers could be mistaken for the upper side of this were it not that this is larger. It measures 17.5 by 15.5 inches. A ridge 5 inches high at one point runs through the center. One-half of the mass is not over 3 inches thick, part of it is only 2 inches, and around the edge it is only 1 inch or less. It is only exceeded in size among the irons seen to fall by the Nejed, central Arabia, which fell in the spring of 1865 and weighs 59.42 kg. The weight of the Cabin Creek iron is 107.5 pounds (44.213 kg.) and it is intact with exception of three small points, weighing not more than 2 ounces in all, which were broken off.

The two sides are wholly dissimilar. The upper side is ridged and deeply dented, while the lower side is flat and covered with shallow, but very large, pittings. On top the color is in many places, almost tin white without any coating whatever, and the pittings are very deep and usually quite long, like finger depressions made in potter's clay. These depressions measure from 2 to 4 cm. and from 1 to 4 cm. This side is remarkable for striæ showing the flow and fusion and all running from the center toward the edge, identical with those of the Rowton, Nedagolla, and Mazapil irons, but on a larger scale. Some of them are thinner than a hair and yet twice as high (like a high knife edge), and they are from 1 to 4 inches long. In one space of 5 cm. 20 are arranged side by side, and on one small part which is black, there are 50 lines in 1 inch of space (25 mm.) all running in the same direction. Near all the pointed edges

the fused metal has flowed and cooled so as to hang like falling water. The striæ and marks of flow are around the edges of the upper surface On the under side pittings are very shallow but much broader, one depression, apparently made up of four pittings, being 20 cm. long and 9.5 cm. wide The whole side is coated with a black crust, 1 mm. thick and having minute, round, bead-like markings On one of the indentations of the lower edge the crust has a strikingly fused appearance as if a flame had been blown upon it from the other side. In reality this edge is undoubtedly the place where a greater amount of fusion took place when the body was passing through the air. Seven small bead-like lumps, from 5 to 10 mm. in size, which are visible on this side, are drops of metal that were entirely melted and flowed and cooled so that they resemble drops of a thick liquid. There are also to be seen what appear to be cracks, 15 in number, and nearly as thin as a hair. One of these is 10 cm. long and extends from the highly fused edge above mentioned toward the center. The others are from 3 to 5 cm. long. These are so evenly arranged that they are without doubt "Reichenbach lamellen" in which the inner troilite has been fused out. If such is the case they are as abundant as in the Staunton, Virginia, iron.

On the upper side 10 nodules of troilite are exposed, measuring from 33 mm. in diameter to 55 mm. in length and 25 mm. in width. On the lower side there are 12 such nodules exposed, 13 mm. in diameter, while the largest measures 19 mm. by 39 mm. On the upper side these nodules are coated in spots with a black crust similar to that found on the mass, but on the lower side the crust extends completely around the side of the nodules, showing the fusion very plainly. The troilite is very bright and fresh, like a newly broken mineral, and on the upper side one of the nodules shows deep striation, suggesting that the entire nodule is one crystal and the exposed part is only one side of it. In some cases where the nodules were broken they were found to be iridescent.

The iron is octahedral in structure and shows the Widmannstätten figures beautifully on etching. The lamellæ are 1 mm. wide and the markings resemble those of the Rowton and Mazapil irons. Specific gravity, 7.773.

Troilite is very abundant in the mass. Schreibersite and carbon have also been found between the laminæ. Chlorine is present only in slight quantity, as scarcely any deliquescence has been observed.

Analysis by Whitfield:[2]

Fe	Ni	Co	P	C, S, etc.	
91.87	6.60	trace	0.41	0.54	=99.42

From the fact that the ridged side is so free from crust and the flat side so thickly coated, that the ridged side is covered with striæ and marks of flowing, and that the other has so few marks of this kind, and from the fact that at the edges, especially at the indentation, the back looks as though a flame had come from the other side—from all these facts the writer concludes that after entering our space the iron traveled with the ridge surface forward, the iron burning so rapidly as to be torn off, leaving part of the surface bright. The flame thus passed over the sides, and the indented edge being downward, the flame was driven upward as the iron advanced. The flat side, not being so much exposed the iron was not so completely consumed, hence a crust and large but shallow pittings. These conditions would perhaps have been entirely different had the mass been round or thicker, for it evidently moved as straight as possible without rotating at all. That it was found in the hole with the flat side down was due perhaps to the fact that, having lost its impetus, it turned in falling, or, as Professor Newton suggests, it may have been turned by striking the tree, and then have fallen downward almost in a straight line.

As the iron only penetrated to a depth of three feet (90 cm.) the earth where it struck must have been very compact and the force of the body itself nearly spent.

In the account published in the Proceedings of the U. S. National Museum, Kunz [3] repeats the above version, adding extracts from local papers descriptive of the phenomena of fall.

Brezina [4] gives the following description of the mass:

Cabin Creek, the largest of the irons whose fall has been observed, of 47.4 kg. weight, is, with exception of a small corner which has been cut off, in its original form. It is highly oriented in the manner of an eccentrically embossed shield. The raised front side is covered with numerous pittings, mostly 3 cm. in size, which indicate quite distinctly the drift of the fine, black, shiny fusion crust, and frequently an unmelted remainder of troilite is found upon the bottom of these pittings. The even, sharp-cornered rear side which borders upon the front side shows a few large shallow pittings measuring 5 cm. across, a thick, dull, barklike crust, and like the front side, troilite nodules half melted out. From this piece only a few small plates of some 29 grams weight were cut off. One of these showed, in addition to the sharp wedgelike border of the principal mass, an unusually deep penetration of the zone of alteration extending from the thick rear bark to a depth of 8 to 14 mm. This rear crust, cut diagonally in the section, appears to be 1.5 mm. wide and is laid on in layers parallel to the outer surface. The zone of alteration cuts across the unchanged interior independently of the unevenesses of the outer surface in a rounded ellipse. The laminæ are crowded together and are somewhat puffy. Tænite is well developed, frequently running out into a substance which upon etching does not show a brownish yellow color but remains silver-white. The fields are filled, sometimes with kamacitelike repetitions of the bands, sometimes with half-blended skeletons, sometimes with dark gray plessite.

The meteorite is preserved almost entire in the Vienna Museum collection.

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CACARIA.

Hacienda de Cacaria, State of Durango, Mexico.
Latitude 24° 28′ N., longitude 104° 50′ W.
Iron. Octahedrite, Hammond Group (Oh) of Brezina.
Found 1867; described 1889.
Weight, 41.4 kgs. (91 lbs.). (Castillo.)

The history and characters of this meteorite have been fully reported by Cohen [11] and a translation of his description will suffice for purposes of this catalogue. His account is as follows:

Barcena [2] first mentioned the Hacienda de Cacaria as a locality for meteoric iron and remarked that the Widmannstätten figures consisted of four-sided fields. According to Castillo [5] the mass was rounded and weighed 41,422 grams. It was found serving as an anvil in Durango, and according to the statement of the blacksmith, came from the Hacienda de Cacaria lying 50 km. northward of Durango. Rath, who saw the meteorite in the National Museum in Mexico, gave the distance from Durango as 42 km. To this mass belongs also the notice of Häpke [3] regarding the find of a new iron meteorite weighing about 40 kg. near Durango. Further, according to the view of Fletcher,[6] the meteorite noticed by Tarayre [1] in spite of the great difference in weight, 200 kg., belongs here. The mass mentioned by Tarayre was also employed as an anvil by a blacksmith in Durango, and Fletcher thinks that two blocks could hardly be employed in this manner in the neighborhood of Durango without this having been mentioned by one of the authors.

According to Brezina [8] Cacaria shows unusual richness in nickel, but the kamacite is almost unaffected by acids. He gives further characters, as follows: Kamacite and plessite equal; both coarse granular. As in Hammond, there appear on etching in place of the tænite, black bands. At one point there is an appearance of tænite 1 cm. long. Regarding the similarity of the different iron meteorites obtained in the neighborhood of Durango, views differ. Fletcher [6] thought that the iron masses known in literature by the names of Labor de Guadalupe, Rancho de la Pila, and Hacienda de Cacaria, belonged to one meteorite fall. Meunier [7] seems to be of the same opinion, at least he unites two of the pieces in the Paris collection having the labels Durango and Cacaria as Rancho de la Pila. He states that they appear to be identical.

He states the characters as: "Kamacite in somewhat bent lamellæ; very delicate tænite threads, and plessite with fully developed combs." From this description and the further facts noted below it is evident that the real Cacaria is unrepresented in the Paris collection.

Wülfing [9] likewise, though only provisionally, united the three above-named iron meteorites. Brezina,[8] on the other hand, considers Cacaria a distinct iron and compares it with Hammond. According to him, the two form a group of octahedrites in which the octahedral structure is produced by dustlike, carbonaceous particles in the place of the tænite, while Guadalupe and Rancho de la Pila are identical with the old Durango and belong to the normal octahedrites of medium width. Häpke,[3] who first had in hand the London Rancho de la Pila, described it as a normal octahedrite, likewise later Fletcher. Regarding the two masses the following may be stated with certainty:

First, the mass in the British Museum, weighing 46,512 grams, which was found in 1882 at Rancho de la Pila, was placed by Fletcher by this name in the museum catalogue and, according to him, Brezina, and Häpke belongs to the normal octahedrites.

Second, the mass in the National Museum in Mexico which is of rounded shape and weighs 41,422 grams, and which was found in 1804 at the Hacienda de Cacaria, is designated by Castillo, Fletcher, and Brezina as Cacaria and does not belong to the normal octahedrites.

Two pieces of the latter mass which I have investigated agree in essential characters as regards their structure, but are so different in chemical composition that a separate description of each seems necessary.

First, Cacaria in the Vienna collection, obtained in Vienna from Castillo. On weak etching the mass of the nickel-iron appears gray, weakly spotted, and slightly lustrous. This in general forms a subordinate groundmass of a homogeneous appearance composed of triangular, rhombic, and trapezoidal fields bounded by little black grains interrupted by little tænitelike particles with smooth, strongly shining faces, forming bands 0.05 to 0.2 mm. in breadth. These bands to the naked eye appear sharply bounded. In reality they are not, since black points lie isolated in the nickel-iron outside of the streaklike aggregations and at times are grouped in a dendritic manner, branching in the immediate neighborhood of the more compact portions. The latter appearance is, however, visible on strong magnification only. The generally rounded to oval, at times elongated, tænitelike particles lie especially on the edges of the field, and are bordered by rows of delicate black grains. On the edge of the piece, close to the natural surface, this tænitelike substance is developed to a length of a centimeter and branches thence into the neighboring nickel-iron. Owing to the ductility of the mass it is not probable that schreibersite and cohenite are present. On strong etching the mass of

the nickel-iron is seen to be made up of grains, part of which show a similarly oriented strong sheen. These are of a very various, highly irregular, angular shape, branching into one another and varying in their dimensions, the majority being 0.02 to 0.03 mm. in diameter, but many sink to 0.01 mm., while others reach the length of 0.5 to 1.5 mm. The larger the grains the more irregularly jagged their shape, as in Hammond; others, at least in part, are surrounded by a dark border which separates them pretty sharply from one another, and this is here so fine that it only becomes visible on strong magnification and a certain amount of etching. To the naked eye an etched surface appears bright and shining from little reflecting flakes probably belonging to schreibersite. Their minute size prevents determination.

Analysis by Fahrenhorst:

Fe	Ni	Co	Cu	Cr	S	P	
92.00	7.70	0.54	0.03	0.01	0.06	0.24	=100.58

Specific gravity=7.7568.

Second, Cacaria obtained by Ward. This piece was cut by Ward himself from the mass in the Mexican National Museum. The principal mass of the nickel-iron appears on weak etching exactly like that of the Vienna piece and shows the same fieldlike portions. The bordering in the latter is, however, different, in that the rows of black grains are lacking, and instead appear little sharply bounded lustrous bands about 0.2 mm. in breadth, probably identical in substance with the isolated rounded to oval tænitelike portions which accompany the black grains. The inclosing of the fields is usually complete, but occasionally the border is interrupted by faces on one side. Further appear between the fields single bands which project on the section in the form of isolated rods. On strong etching here also the chief mass is nickel-iron which appears in irregularly shaped grains the size of which varies in general between 0.5 and 1.5 mm. and a part of which show the same strongly oriented sheen. The grains as a rule cut across the above mentioned bands, though occasionally a grain is penetrated by one or more bands. In spite of varying dimensions the distribution of the grains is more uniform than in the Vienna piece. Open clefts of irregular shape extend inward from the natural surface. Hollows occur which are surrounded by a section of the tænitelike substance 1.25 mm. in breadth. In these fine black, wormlike forms are included grouped into delicate netlike veins, and the same substance seems earlier to have filled the clefts and hollows. Its loss may be due to the manipulation in cutting and polishing. The black inclusions in the two pieces may be of this nature, although they are distributed in a somewhat different way. At one point the tænitelike substance fills a cleft.

Analysis by Fahrenhorst:

Fe	Ni	Co	Cu	Cr	S	P	SiO_2	Residue SiO_2	Chromite	
87.38	12.06	0.65	0.02	0.01	005	0.22	0.16	0.05	0.04	=100.64

Specific gravity=7.7070.

The structural distinction between the two pieces is only quantitative. In the Vienna piece the black particles predominate, in Ward's piece the tænitelike bands. Thus the whole appearance, especially at first sight, is different. It is probable that the higher content in nickel + cobalt in the latter piece is due to the greater quantity of tænitelike substance.

Finally it may be noted that both pieces have few visible accessory constituents and are pretty easily attacked by acids. This latter observation is not in accord with Brezina's statement that the nickel-iron is almost unattacked by acids. Such a difference in the chemical composition in the parts of one mass has not hitherto been observed in an iron meteorite.

The meteorite is chiefly preserved in the National Museum of Mexico.

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CAMBRIA.

Near Lockport, Niagara County, New York.
Here also Lockport.
Latitude 43° 13′ N., longitude 78° 50′ W.
Iron. Fine octahedrite (Of) of Brezina; Lockportite (type 16) of Meunier.
Found 1818; described 1845.
Weight, 16½ kgs. (36 lbs.).

The history and characters of this meteorite have been fully summarized by Cohen,[12] whose account is as follows:

According to Silliman,[1] this iron was found in cultivating a field. It was of irregular elongated shape, 46 cm. (18 inches) long and 14 cm. (5.5 inches) broad. It was covered by an unusually thick rust-crust and showed numerous depressions on the surface which had been produced by weathering out of troilite nodules. This was known by the remains of the troilite in the bottom of the pits. Numerous nodules of troilite found in the interior consisted at the center of pyrrhotite easily attacked by dilute nitric acid. Toward the periphery a yellow, not decomposable troilite was found. Both were surrounded by a line of white amorphous metallic iron.

Olmsted [1] gave two analyses:

Fe	Ni	Cu	Cl	As	Insol.	
94.22	6.35	.....	trace	....	....	=100.57
92.58	5.71	trace	.....	trace	1.40	= 99.69

Specific gravity=7.5257.

Later Silliman and Hunt [2] made a new analysis of the nickel-iron and of the insoluble residue. They found it consisted of magnetic dark gray foliæ mingled with light flakes. Shepard [3] regarded cobalt as being present, while Olmsted, Silliman, and Hunt expressly stated that cobalt was absent. Reichenbach [4] thought that Cambria and Schwetz were similar on account of the similarity of their analyses which were, however, in both cases incorrect. In his description of the trias of octahedrites Cambria was quoted as an example of metallic sheen, swathing kamacite, and combs. Further, he stated that the fields appear brighter in the interior than at the edge, and at times show in the neighborhood of the center a second dark zone. Thus Cambria is midway between the irons with dark and light plessite. Drawing an analogy from agate, he thought that the deposition of the iron took place slowly from the outside toward the center. He also distinguished a bronze colored, easily soluble troilite and an insoluble brass yellow inclining toward brownish-gray mineral which he regarded as pyrrhotite, and mentioned graphite as an accessory constituent. Rose [5] noted the fineness of the Widmannstätten figures, likewise the bordering of many rounded inclusions of troilite of the size of hazelnuts with a thin brass-yellow layer. According to Meunier,[6] Cambria belonged to those octahedrites which consist almost wholly of kamacite but are mixed with some plessite and a little tænite. He designated the group as Lockportite. He described the troilite as intergrown with schreibersite and daubréelite, and bordered with graphite. Rammelsberg [7] made a new analysis which differed essentially from the older. He found it to have the following composition:

Fe	Ni	Co	Cu	FeS	
88.76	10.65	0.08	0.04	0.47	=100.00

Smith [8] first showed that the light yellow mineral bordering the troilite was schreibersite. Brezina [9] described Cambria as follows: "Long, much grouped and banded hatched lamellæ 0.33 mm. broad; fields and combs abundant; plessite dark; large troilite nodules bordered by tænite or schreibersite and these by hatched, swathing kamacite."

Cohen [12] gives the following description of the structure:

Some of the bands are long, others short, and in that case much grouped. The latter are sharply separated from the former and are not swollen. Some of these are hatched, others are spotted, and many show in part one and in part the other formation. The etched pits occur the more abundantly the more the etching lines are lacking. All the bands are coarse-granular, the spotted ones more strongly so than the hatched. This appearance is due to separation, since the striæ cross the clefts undisturbed. At times the kamacite contains little prisms, or elongated grains, of schreibersite or cohenite running parallel with the long direction of the bands and appearing like numerous wavelike projections of the bands. The lamellæ are often more or less bent and not in consequence of the shock of striking the earth. Apparently this is a primary property. The tænite borders are small and visible under the lens. The structure of the plessite is various. A part consists of little dark grains and shining flakes. The former are 0.01 to 0.02 mm. in diameter and seem to consist of black grains with a lighter border. The latter reach at the most a diameter of 0.005 mm. Much of the plessite composed of grains in this manner is uniform through the whole field. The shining flakes are likewise uniformly distributed. Frequently the plessite appears in quadratic or small, elongated fields arranged like a chessboard which are now dull and now shining but not sharply bounded. Such a structure I have never observed in any other meteorite. The bright fields appear on strong enlargement not uniform, but consist of predominant, weakly reflecting grains and again of dull dark ones. Numerous fields are composed of complete lamellæ, some up to 0.1 mm. in breadth and some consisting of such in one-half and in the other half, granular plessite. No combs

were observed. The troilite nodules which I observed are uniform normal troilite bordered by a bright one of schreibersite. From the latter, processes extend out into the nickel-iron. The whole is surrounded by swathing kamacite which is partly hatched and partly spotted.

The meteorite is distributed, the British Museum possessing the largest piece.

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Caney Fork. See Smithville.
Caryfort. See Smithville.
Coney Fork. See Carthage.

CANTON.

Cherokee County, Georgia.
Here also the Cherokee meteorite, Cherokee Mills, and Cherokee County, 1894.
Latitude 34° 12′ N., longitude 84° 30′ W.
Iron, Coarsest octahedrite (Ogg) of Brezina.
Found 1894.
Weight, 7 kgs. (15.5 lbs.).

The first description of this meteorite was by Howell [1] as follows:

This meteorite was found in March, 1894, by Mr. S. B. May, a few hundred yards from the Clarkson gold mine, 2.5 miles east of Cherokee Mills, and about 5 miles southwest of Canton, Cherokee County, Georgia.

Mr. May was ploughing new ground when he discovered the meteorite, only partially covered with soil. It was of a rough lens shape with one side flattened and weighed 15.5 pounds. With the aid of an axe the mass was finally separated and the smaller part was carried away, mislaid, and apparently lost beyond recovery by a party who did not appreciate its value. The larger portion weighed 8.5 pounds, having evidently been reduced in size and weight by oxidation, leaving, however, a solid mass after the oxidized portions were removed.

The Widmannstätten figures are strongly marked and distinctive, the special feature being the large masses of plessite.

Analysis by H. N. Stokes:

Fe	Ni	Co	Cu	Si	P	S	C	
91.96	6.70	0.50	0.03	trace	0.11	0.01	trace?	=99.31

The only other meteorite to my knowledge found in that portion of the State is the Losttown found in 1868 and described by Shepard.

This, however, is very different in appearance and composition, containing 6.70 per cent of nickel, while the latter contains only 3.66 per cent, which alone would be sufficient to distinguish them.

The name indicated by Howell for the meteorite in the title to his paper was the Cherokee meteorite. Owing to the proximity of the place of find to that of the Losttown meteorite Brezina [2] included Cherokee Mills with Losttown. In this he was followed by Wülfing.[3] In Ward's [4] catalogue, however, the two are separated as they doubtless should be on account of their differences in structure, and the name Canton given to the above described meteorite.

The meteorite is distributed.

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Caparassa. See Toluca.

CANYON CITY.

Trinity County, California.
Latitude 40° 55′ N., longitude 123° 5′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1875; described 1885.
Weight, 8.6 kgs. (18¾ lbs.).

This meteorite was first described by Shepard[1] under the heading "Meteoric Iron from Trinity County, California," as follows:

For my knowledge of the meteorite here described, I am indebted to Col. Joseph Willcox, who incidentally mentioned to me last autumn that he had seen some years ago a metallic mass at Holmes Hole, Massachusetts, brought from California, that he suspected to be of meteoric origin. It was in the possession of Capt. C. W. Davis, who procured it 10 years ago at Canyon City in Trinity County. Through the kindness of Mr. A. F. Crowell, of Woods Hole, a few grams were obtained from Captain Davis for examination and analysis; the result of which has been that the meteoric origin at first regarded as doubtful has been established.

The first portions that were detached had the appearance of pure limonite, but were afterwards proven to contain minute particles of nickeliferous iron, small fragments being readily attracted by the magnet. The thickness of the crust affording this limonite must have been at least 0.1 inch; whence it may be inferred that the meteorite had originated in a very ancient fall. The specific gravity of the limonite was between 3.81 and 4.04. It was compact, but yielded to pulverization, with exception of occasional very fine metallic grains, that flattened slightly by extreme pressure under the pestle. The application of the magnet took up more than this powder, which principally consisted of the limonite. It was thus found to be impossible to separate it from the metallic portion.

Two small fragments of the nearly unaltered interior were supplied for analysis. In these the coarsely-grained nickeliferous iron was apparent, affording cleavable crystals of the octahedral form, similar to what is found in the Putnam iron, that of Cocke County, and others. The specific gravity of these fragments was 7.1, which is less than the average for meteoric irons, a circumstance to be expected from the slight adhesions of hydrated peroxide of iron. To the same cause may be ascribed the small loss in the subjoined analysis:

Fe	Ni	Co	P	
88.81	7.278	0.172	0.12	=96.38

For want of material no search was made for tin, copper, or manganese. No sulphur was present in the portions examined. The weight of the mass is 19 pounds. Its shape is oval, somewhat flattened, with numerous elongated depressions.

Brezina,[2] from the similarity in name with Canoncito, grouped this meteorite with Glorieta, and in this he was followed by Wülfing.[3] Ward,[4] however, obtained later the original mass and gave a further description of it as follows:

Shepard called attention to a mass of meteoric iron purporting to come from Canyon City, Trinity County, California, whence it had been brought by Capt. C. W. Davis, of Holmes Hole, Massachusetts, some 10 years previous.

By the aid of Mr. A. P. Crowell, of Woods Hole, I was able to find Captain Davis and to obtain the specimen, which the latter gentleman had had in his possession for more than a quarter of a century. Captain Davis's recollections of the finding of the mass were clear, yet with little detail. It was found in the summer of 1875 on the border of a little stream which flows into the Trinity River, and about 3 miles northeast from the town of Canyon City. It was brought to Captain Davis by John Driver, who discovered it on the surface of the ground. Captain Davis retained it entire during his stay of several years in Canyon City, and subsequently brought it with him to his Massachusetts home, where he had since kept it carefully wrapped in a napkin and had shown it to few visitors.

The form of the specimen was nearly a square, about 8.5 by 7.5 inches in length and breadth, and 2.5 inches in average thickness. One surface was slightly convex, the other slightly concave. The whole surface was much oxidized, and the flaking off of scales of the decomposed iron had entirely obliterated any traces of pittings which it originally doubtless had over its surface. The general color of the whole is dark yellowish-brown. The weight before cutting was 18.75 pounds. Several slices have been cut from the mass.

The etched sections show a strongly-marked octahedral structure with large figures; the plates of kamacite vary much in size, ranging generally from 1 to 2 mm. in diameter, with an occasional broader one of from 2 to 4 mm., as shown in the cut. The bands of tænite are broad and quite prominent throughlout the mass, the plessite in many places showing these bands crossing them in parallel layers (laphamite markings). This is shown particularly well on some of the edges of the slices which have been oxidized, giving the tænite a somewhat comb-like effect from their relief above the weathered kamacite.

No schreibersite was noticed by a macroscopical examination. The largest troilite nodule found in any of the sections is not over 2 mm. in diameter; others range from this down to the fraction of a mm. These latter were quite abundant, as many as 16 of them being scattered over some of the slices. On the narrow end of three of the slices is a fissure, entirely crossing the slice, filled with troilite.

Some sections show that the oxidation of the surface had extended inward to the depth of 5 mm. in some places. This readily accounts for the nonappearance of crust on the exterior surface of the mass, as well as the tendency in some places to scale; also for the limonitic color of the whole.

The examination of this iron by Professor Shepard was limited to two small pieces—barely an ounce in all—which were from the outer surface, "and had the appearance of pure limonite." It was thus, as he suggests, difficult to obtain either an exact analysis or exact specific gravity. This circumstance sufficiently accounts for the difference between his analysis and the one lately made by Mr. J. M. Davison, of Rochester, New York, as follows:

Fe	Ni	Co	P	
91.25	7.85	0.17	0.10	=99.37

Specific gravity, 7.68.

Although the town of that name no longer exists, the mass was named Canyon City when Professor Shepard wrote his paper and accordingly still retains the name. Mitchell's Atlas, edition of 1885, has Canyon City on the right bank of a branch of the Trinity River in the center of Trinity County, latitude 40° 55′ N., longitude 123° 5′ W. It is satisfactory to be able thus to see rescued from the oblivion of uncertainty a meteorite which for more than a quarter of a century has been known by name, yet absent and unknown in substance.

The principal mass is in the Ward-Coonley collection.

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CANYON DIABLO.

Coconino County, Arizona.
35° 10′ N., 111° 7′ W.
Here also Arizona, 1891.
Iron. Coarse octahedrite (Og) of Brezina; Arvaïte (type 7) of Meunier.
Found and described 1891.
Total weight unknown. About 6,000 kgs. (6 tons) are preserved in collections.

The first description of these meteorites was given by Foote[1] in 1891. He says:

In the latter part of March, 1891, a prospector in Arizona informed the mining firm of N. B. Booth & Co., of Albuquerque, New Mexico, that he had found a vein of metallic iron near Canon Diablo, sending them at the same time a piece for assay, and stating that a car load could be taken from the surface and shipped with but little trouble. I therefore visited the locality in June, 1891, with a view to determining the probable nature of the find. * * *

Nearly all the small fragments were found at a point about 10 miles southeast from Canon Diablo near the base of a nearly circular elevation which is known locally as "crater mountain." (Sunset Knoll in the U. S. Geological Survey.) This is 185 miles due north from Tucson, and about 250 miles west of Alberquerque.

The elevation, according to the survey, rises 432 feet above the plain. Its center is occupied by a cavity nearly three-quarters of a mile in diameter, the sides of which are so steep that animals are unable to escape from it. The bottom seemed to be from 50 to 100 feet below the level of the surrounding plain. The rocks which form the rim are of sandstone and limestone and are uplifted on all sides at an almost uniform angle of from 35 to 40 degrees. A careful search, however, failed to reveal any lava, obsidian, or other volcanic products. It is impossible, therefore, to explain the cause of this remarkable geological formation.

About 2 miles from the point at the base of the crater in a nearly southeasterly direction, and almost exactly in a line with the longest dimensions of the area over which the fragments were found, two large masses were discovered within about 80 feet of each other. The area over which the small masses were scattered was about one-third of a mile in length and 120 feet in its widest part. The longer dimensions extended northwest and southeast.

The largest mass discovered weighed 201 pounds and had a somewhat flattened rectangular shape showing extraordinarily large and deep pits, three of which passed entirely through the iron. * * *

Another large mass was found weighing 154 pounds also deeply pitted. A mass weighing approximately 40 pounds was broken in pieces with a trip hammer, and in cutting one of the fragments of this piece diamonds were found. Smaller masses to the number of 131 were discovered ranging in weight from $\frac{1}{16}$ of an ounce to 6 pounds 10 ounces. A brownish-white slightly botryoidal coating found on a number of meteorites is probably aragonite. Accompanying the pieces found at the base of the "crater" were oxidized and sulphuretted fragments which were of undoubted meteoric origin. About 200 pounds of these were secured, ranging from minute fragments up to 3 pounds. These fragments were mostly quite angular in character, and a very few showed a greenish stain, resulting probably from the oxidation of the nickel. This oxidized material was identical in appearance with an incrustation which covered some of the iron masses and partially filled some of the pits.

In cutting pieces of the iron for study it was found by Prof. G. A. Koenig to be of extraordinary hardness, destroying several chisels and an emery wheel. A section revealed a cavity in the interior of the mass which contained small, black diamonds, which cut through polished corundum as easily as a "knife cuts through gypsum." * * * Granules of amorphous carbon were also found in the cavity, a small quantity of which treated with acid revealed a minute white diamond of one-half mm. in diameter. In manipulation this specimen was lost. Troilite and daubréelite were also found in the cavities. The proportion of nickel in the general mass was determined by Koenig as 3 per cent.

Koenig further stated that the presence of black and white diamonds was established by the hardness and indifference to acids of the specimens; that carbon in the form of a pulverulent iron carbide occurred in the same cavities with the diamonds; that sulphur was not contained in the tough, malleable portion, but in the pulverulent part of the meteorite; that phosphorus was contained in the latter but not in the former; nickel and cobalt in the proportion of 2:1 were contained in both parts equally; that silicon was only present in the pulverulent part; that the Widmannstätten figures were not regular; that the iron was associated with a black hydroxide containing Fe, Ni, Co, and P, in the ratio of the metallic part and therefore was presumably derived by a process of oxidation and hydration of the latter. * * *

The remarkable quantity of oxidized black fragmental material that was found at those points where the largest number of small fragments of meteoric iron were found would seem to indicate that an extraordinarily large mass of probably 500 or 600 pounds had become oxidized while passing through the air and was so weakened in its internal structure that it had burst into pieces not long before reaching the earth.

The composition of some of the Canyon Diablo meteorites was studied in detail in 1893 by Moissan [6] with results as follows:

Among several specimens subjected to analysis there was one very important specimen weighing, it is true, only 4.216 grams, but presenting very distinctly a point of great hardness upon which a burr of steel made no impression whatever. When closely examined this specimen showed distinctly that the fragment which scratched the steel was enveloped in a black sheath formed of carbon and carburet of iron.

This specimen was attacked by boiling chlorhydric acid until there was no trace of iron remaining; there was then obtained a compound containing:

1. Very free carbon, in an impalpable powder, requiring 12 hours to sink to the bottm of the liquid, and which probably proceeded from the attack of the carburet of iron.

2. Carbon in very thin, ribbon-like fragments, of a maroon color under the microscope, and appearing jagged like the carbon of a peculiar character which is found in crucibles upon suddenly cooling them.

3. A dense carbon, occurring especially in rounded fragments and mixed with small particles of phosphuret of iron and nickel with a reddish-brown reflection. This mixture was treated alternately by boiling sulphuric acid and fluorhydric acid; its density was then sufficient for it to fall to the bottom of the iodide of methylene.

This last residue was subjected eight times to the action of chlorate of potassium. The fragments, of a dark color, disappeared little by little at the same time that a small quantity of iron entered into solution. Finally there remained only two yellowish fragments with a greasy appearance, very distinct, not possessing triangular impressions, and whose rough and warped surface resembled the crystallization of *boort*.

These two fragments fell to the bottom of the iodide of methylene, scratched ruby distinctly, and one of them, burned in oxygen, left cinders preserving still the form of the fragment. The largest of these fragments measured 0.7 mm. by 0.3 mm. and possessed a yellow tint, a rough surface, and was translucent.

In another specimen there was found, mixed with phosphurets and sulphurets of iron and nickel, a crystalline substance of dendritic form of a gray color, duller than platinum, which did not disappear in the treatment with fluorhydric acid and aqua regia. Some fragments of black diamond also were encountered in this specimen, with a shagreened or bright surface, with a density of about 3 and burning in oxygen at 1000° C.

There should not be confused with this certain particles of oxide of magnetic iron, incombustible in oxygen, and entirely impervious to sulphuric acid, which is produced by the oxyde Fe_3O_4 obtained at a very high temperature.

The meteorite was also found to be lacking in homogeneity. Two specimens taken from points 1 cm. apart furnished the following figures:

	Fe	Ni	Silica	Insoluble	Mg	Ca	P	S	
1.	91.12	3.07	0.050	1.47	traces	.....	0.20	.....	=95.91
2.	95.06	5.07	.....	0.06	.....	.....	.....	.....	=100.19

The two specimens which contained carbon in various quantities contained no sulphur.

Another fragment which gave no traces of carbon yielded the following:

	Fe	Ni	SiO_2	S	
1.	91.09	1.08	0.05	0.045	=92.265
2.	92.08	7.05	....	.....	=99.13

Moissan also dissolved 53 kg. of Canyon Diablo in pure HCl. An insoluble residue weighing 800 grams was left, in which he found, besides carbon in the form of amorphous carbon, graphite and diamond, an iron phosphide, P_2Fe_3, and silicon carbide (carborundum) SiC. The iron phosphide occurred as little needles or as cubes. Analysis gave:

	Needles			Cubes	P_2Fe_3 Calc.
P	26.97	26.95	.....	26.46	26.95
Fe	71.63	72.15	73.51	72.43	73.05
Ni	trace.				
C	trace.				

The silicon carbide occurred in little green hexagonal crystals. This was its first noted occurrence in nature.

Friedel[7] about the same time investigated the meteorite. He did not find the white diamond in very large grains; but, in examining with the microscope the powder of the *carbonado* diamond, which was quite abundant, and taking care to immerse it in iodide of methylene, he was able to discern among grains having exactly the appearance of small masses of the well known carbonado, a certain number of small transparent grains which he regarded as white diamond. The statement of Moissan concerning the extreme heterogeneity of the Canyon Diablo meteorite was confirmed by Friedel. He also mentions a bright compound, silver white in appearance, fragile, less easily attacked by acids than iron, which occurred in comparatively thick plates included between the crystals of nickel-iron, accompanied in this position by laminæ of schreibersite. This latter was distinguished by its ductility. These laminæ stood out slightly on a polished fragment.

Friedel isolated a small quantity of this material and recognized it as a subsulphide of iron containing 10.2 per cent of sulphur and 88.3 per cent of iron. There was also a small quantity of phosphorus which could not be certainly measured on account of the small quantity of material at disposal. The proportion above, if it could be considered as constant, would correspond to the formula Fe_5S.

Besides this sulphide disseminated in the mass, there were nodules of yellow troilite, in which, or in the neighborhood of which, carbon, that is to say, the mixture of ordinary carbon, graphite, and diamond, appeared to be concentrated. The nodules were composed partly of troilite, partly of carbon penetrated by this same sulphide. The nodules themselves were enveloped in a thin layer of bright subsulphide.

The occurrence of diamonds in the Canyon Diablo meteorites as well as others was discussed by Meunier[10] with the following conclusions:

The irons in which diamonds are found are far from having the characteristics which may be called normal; they depart greatly from the description which fits the typical meteoric irons.

The latter, cut with the saw and polished, are of a more homogenous appearance than our finest steel, and appearance which contrasts with their real heterogeneity; it is only under the action of acids that they show the network of figures called Widmannstätten lines and which reveal the coexistence of alloys very unequally soluble.

In the iron of Cañon Diablo, it is enough to saw a surface, without polishing, in order to obtain, without the use of an acid, a mosaic which may suggest the Widmannstätten figures, but which has nothing whatever in common with them and which disappear upon polishing. These markings result from the existence, in the midst of the mass of a nickel iron ore more or less homogenous, of laminæ of a phosphuretted material known under the name of schreibersite, occurring in small amount in ordinary irons where it is quite otherwise disposed.

The iron of Magura (Arva), said to contain adamantine grains, belongs distinctly to the same lithological type as that of Cañon Diablo; the type under which comes also, with certain others, the Smithville iron. These masses are partly of the type designated by the name Arvaite in the collections of the French Museum.

As to the irons which yield the beautiful Widmannstätten figures, they contain in general very little carbon and sometimes not a trace of it.

Meunier [9] also notes that—

The schreibersite is not uniformly distributed, large surfaces being entirely free from it, but where it is present, as is usually the case, it produces the appearance and orientation of the Brazos and Sarepta masses. The etching figures are exactly identical with those of the Brazos iron and show like it broad bands of kamacite associated with thin filaments of tænite.

Brezina [17] notes that—

Among all known meteoric irons Cañon Diablo furnishes the largest number of immense blocks, weighing 500 kg. and upwards, although a few fall short of the large Mexican masses. Like Penkarring Rock, this iron has a tendency to orifices from the surface, and in the case of the smaller pieces, of a few kilograms weight and upwards, to the separation of sharp angled individuals, which appear almost like metallic potsherds, only much more sharply pointed. Moreover, the exterior of such small individuals is divided in a most singular manner; it seems as if, in an iron furnished with pittings, these depressions had simultaneously been enlarged until they touched and intersected one another, so that only the wave-crests arising from the intersection of the very shallow cavities remained of the elevations between them. Frequently this peculiarity of the exterior is to be seen only on the broad side of the clod-like pieces, while the other side has been rendered convex by widespread weathering; many such pieces show that the rounded side was buried in the ground, which is abundantly proved by the still adhering particles of a calcareous deposit. Small fresh formations on this coating (stalactitic deposits of from 1 to 2 mm. in length) likewise show by their situation that the iron flakes were imbedded with their broad sides horizontal. By weathering to limonite a flat stratification (with a preference for octahedrons) is formed at times whereby frequently the remnants of the refractory tænite distinctly mark the direction of the octahedral laminæ, as is the case on fresh iron after etching. That is to say, the triad resists the action of acid very markedly, and by the complete recession of the tænite and the indifferent condition of the kamacite as well as the scarcity of fields, the etched iron frequently appears like an ataxite. Most pieces are very refractory to etching; this is so in case of pieces composed almost entirely of kamacite, without any visible tænite or other admixture. Less frequently portions occur which show ribs of cohenite in the kamacite; on such pieces the kamacite is customarily more easily affected by the acid and by the employment of a more powerful acid it readily receives scratches. Occasionally huge nodules of troilite and graphite from 10 to 15 cm. in size occur in the iron.

Huntington [14] in 1894, published a further investigation into the occurrence of diamonds in the Canyon Diablo meteorites, the tests of Friedel to this end not being deemed by him conclusive. He examined about 200 pounds of the iron, selecting the pieces most likely to afford diamonds. These were then dissolved. He states:

Most of the iron dissolved contained no diamonds whatever. One piece, however, in the process of dissolving, showed an irregular vein running through it, consisting of a white vitreous substance, varying in width from a fine line to nearly 4 mm. This vein stuff proved to exceed the ruby in hardness. On further examination, it appeared to be a mixture of iron, a sulphide of iron, silica, amorphous carbon, and diamond, and had to be crushed to get rid of all the iron.

The hardest grains of this vein substance were isolated, and when examined under the microscope one minute but perfect octahedron of diamond was found, transparent and colorless. It was separately mounted in a microscope slide, but soon disappeared, and in its place were found only some very minute angular fragments. A second crystal was afterwards isolated, but disappeared in like manner, suggesting that they had been formed under pressure, and when exposed in a warm room, had exploded.

About half a carat of diamond powder was finally obtained, being separated by its specific gravity from a very large quantity of amorphous carbon. The particles varied from colorless through yellow and blue to black. Many of them appeared to be angular fragments, though some of them looked not unlike hyalite, except for their more brilliant luster. Several perfect little octahedrons were found that did not break up. The original specimen measured only a little over a hundredth of an inch in diameter, but when viewed through a two-thirds objective it showed distinctly the hexahis octahedral planes, the curved edges, striations, etc., adamantine luster and clear water of the diamond crystal.

A newly planed wheel in the Tiffany Exhibit at the Columbian Exposition, was charged with the residue from the Cañon Diablo iron, and when a rough diamond was placed upon the wheel it immediately gave out a sharp hissing sound, and in a few minutes a face was ground down and polished. Two other diamonds were cut and polished in the same way. In all respects the residue from the Cañon Diablo iron was found to act exactly like any other diamond powder.

These experiments were regarded by Huntington as establishing the fact that the Canyon Diablo iron contains true diamonds, and not some new allotropic form of carbon.

The possibility of a terrestrial origin of the Canyon Diablo meteorites was also discussed by Huntington [14] with the conclusion that such an origin is disproved by an examination of the exterior surface of a mass weighing 1,087 pounds in the Harvard Museum. He says:

It is a roughly spherical mass somewhat flattened in one plane. One of these flattened surfaces shows signs of fusion, with deep pittings almost like bullet holes, but larger on the interior than at the orifice. Occasionally, they are meeting, but all preserve the same general direction. They vary from $\frac{1}{16}$ to 2 inches in diameter and reach in some cases a depth of 3 or 4 inches. These can not be explained by unequal heating or by the erosive action of the air, since they are larger on the interior than at the surface. The other side of the mass shows large concave surfaces, as if pieces of 6 or 7 inches in diameter had flaked off, or the hollows had been scooped out by the action of pneumatic drills.

For some time these two utterly different surfaces were a puzzle, but a closer examination disclosed troilite in the depths of some of the small cavities, while in the side of the larger pittings the same mineral appears exposed but unaltered. Evidently, then, this mass must have been a meteorite, moving with its smoother face to the front, and perhaps revolving. In such a case the front would acquire the melted appearance observed, and the troilite nodules would at once fuse and become dissipated, leaving the deep and erratic cavities so characteristic of this iron, while the portion in the rear would acquire the well-known pittings due to the flaking off of irregular portions. The iron is largely filled with troilite nodules, and that they did not subsequently weather away is evident from the fact that these cavities appear only on the front of the mass.

The etched surface shows great variation in the distribution of the Widmannstätten figures and troilite nodules, and the occurrence of diamond evidently varies likewise.

Cohen remarks:[15]

It is not yet certain whether the Cañon Diablo iron is meteoric or, like the Greenland nickel-iron, of terrestrial origin; in common with the latter it has a very low percentage of nickel, at least in portions of it, and a comparatively high percentage of carbon.

Derby [16] investigated a Canyon Diablo specimen as to its constituents and obtained results as follows:

A specimen of the Cañon Diablo meteorite, obtained from Mr. E. E. Howell, of Washington, and stated to be one of the original lot brought from Arizona by Dr. A. E. Foote, was treated by the fractional method of Prof. E. Cohen by Dr. G. Florence, with the following results:

The specimen, weighing nearly 200 grams, was a perfect meteoric individual, presenting no fractural surfaces, but everywhere the rough pitted surfaces of meteoric masses. In appearance it suggested a metallic bleb, broken or weathered out of friable, or more easily decomposable material. An examination of a considerable number of specimens of all sizes in Mr. Howell's collection shows this to be a general characteristic of the Cañon Diablo group. Nothing in the shape and aspect of the masses suggests the occurrence of planes of slight cohesion (presumed to be the limits of crystalline individuals described as Wollaston planes in the Bendego mass) and which, by facilitating fracture, either in the original place of formation, or in the act of falling, have probably produced the approximately plane faces and angular edges that characterize that meteorite. Such faces and edges might be expected on the Cañon Diablo mass, which seems to be required by the conditions under which they were formed. A rough, jagged, and pitted surface is, however, common to all of them, showing a perfect individualization and suggesting on a large scale, the small, irregular metallic masses scattered through the stony matrix of a mesosiderite. Referring them to a single original mass, the hypothesis may be ventured that on its arrival in our atmosphere this was not homogenous but consisted of a large mesosiderite with unusually large metallic nodules of that became separated by the explosions attending the fall, and probably also by subsequent decay and disaggregation of the stony matrix.

After freeing the specimen as far as possible from its rust crusts by scraping after soaking in strong acid, it was treated with cold hydrochloric acid of a strength of 1 to 10. The solution was effected slowly with evolution of gas and a separation of a variety of grains with a metallic aspect and of a light black residue resembling coal dust. A veinlike mass some 3 mm. thick, that showed through the rust crust with the appearance of the pencillike incusions of troilite in the Bendego meteorite. extended for about a centimeter into the mass, and, not being acted upon by the acid, came away in fragments. After 14 weeks of treatment with frequent changes of acid the action almost ceased, although a considerable mass remained still undissolved. This had much the shape and appearance of the original meteorite though much more irregular and jagged, and represents a nucleal portion less soluble than the generality of the mass.

The undissolved residue was separated by screening through fine bolting cloth, sorting under the lens, and with a magnetized knife point, into the following groups: Vein matter consisting of massive schreibersite with cohenite; irregular jagged fragments resembling the larger nucleal piece and bristling with needles of rhabdite (*zackige Stücke* of Cohen?); tænite; coarse schreibersite and cohenite from the general mass and not from the vein (a considerable part of the schreibersite was free but the grains of cohenite were so charged with it that no satisfactory separation of the two could be effected); fine magnetic residue, for the most part schreibersite in the form of rhabdite needles but with fine particles of tænite; granular schreibersite and cohenite, and a black coal-dust-like residue highly charged with rhabdite. The separation could not be completely made except for the jagged pieces and the coarser tænite, schreibersite, and cohenite. In the finer material the two last were so lumped together that neither by sorting nor by gravity or magnetic

methods could they be satisfactorily separated. An attempt to separate the light coaly matter by the use of the Thoulet solution was only partially successful, as a small amount of the black particles were carried down with the heavy metallic grains and a larger portion of these were retained by the spongy, coaly particles. The proportions given below, calculated for the dissolved portion after deducting the nucleal piece and vein matter, are therefore only approximate:

	Grams.	Per cent.
Original specimen	195.	
Large jagged nucleal piece	9.1855	
Vein matter, schreibersite and cohenite	2.971	
Small jagged pieces	1.4105	0.78
Tænite	1.872	1.02
Coarse schreibersite and cohenite	7.5835	4.14
Fine magnetic residue mainly schreibersite, in part acicular (rhabdite), with some tænite and cohenite	1.4945	0.82
Fine nonmagnetic residue with rhabdite	0.517	0.28
Dissolved	169.966	92.95
		100.00

An analysis of 100 cc. of the solution corresponding approximately to 0.5 grams of the meteorite (except for the copper determination which was made with 500 cc.) gave:

Fe	Ni Co	P	Cu	
91.264	9.252	0.44	0.44	=100.00

This result agrees fairly well with the composition of kamacite (Fe 93.11, Ni, Co 6.89) according to the formula $Fe_{14}Ni$ as given by Cohen. As the proportion of phosphorus and copper is higher than in the greater part of Cohen's analyses in which for the most part weaker acid was employed, it may be presumed that the elements rich in nickel, tænite, schreibersite, and the coaly substance were more strongly attacked, giving an enrichment in nickel. Making allowance for this circumstance, the dissolved portion may be considered as consisting essentially of normal kamacite.

A large jagged piece which was only attacked with extreme slowness by cold acid of a strength of 1 to 10 was tried with acid 1 in 5 without much better results in the cold. Upon heating on the water bath vigorous action commenced and continued even after the acid was much diluted. At times the action would continue in the cold after removal from the bath, at others it would almost cease in the hot acid and only recommence with vigor on the addition of a considerable quantity of fresh acid. At other times the action would continue until the acid was completely exhausted and a precipitate began to appear in the solution. These variations in the action of the acid indicate a lack of homogeneity and varying degrees of solubility in different parts of the mass. The residue was similar to that of the original mass except that cohenite was almost entirely lacking. The principal contrast in the two residues was in the greater relative abundance of rhabdite and the less abundance of granular schreibersite and the coaly matter in that of the jagged piece. The coaly matter was evidently partially destroyed by the action of the hot acid and the residue was entirely freed from it by treatment with strong cold acid, a white, flocculent skeleton remaining.

The large piece was broken up as follows:

	Grams.	Per cent.
Original specimen	9.1855	
Tænite	0.029	0.31
Schreibersite (granular 0.0075 grams, 0.08%; acicular 0.0255 grams, 0.27%)	0.033	0.35
Nonmagnetic residue	0.325	0.34
Dissolved	9.094	99.00
		100.00

An analysis of the solution gave the following result (copper was determined in the whole solution, the other elements in 100 c. c.):

Fe	Ni Co	P	Cu	
94.32	5.78	0.15	0.05	=100.30

This composition agrees very nearly with that of the "*zackige Stūce*" of Toluca given by Cohen, and, like that, shows a higher proportion of iron and a lower proportion of nickel and cobalt than the general mass of the meteorite and of normal kamacite. The occurrence of rhabdite is not noted in the case of Toluca but may perhaps be presumed from the relatively high percentage of phosphorus.

The nonmagnetic residue consisted mainly of rust particles and some dirt, evidently derived from laboratory dust. Nothing of any interest that could be referred to the meteorite could be detected in it by microscopic examination.

The small jagged pieces were dissolved in copper-ammonium chloride with the view of determining the amount of carbon, but owing to an accident this determination was lost, and only the relative proportion of granular (1.84%) and of acicular (1.16%) schreibersite was determined. The amount of the coaly residue was apparently greater than in the treatment with acid. The higher proportion of schreibersite may be referred in part to the slighter action of

the solvent, by which more of the original content is recovered, but it is also evident that this mineral, particularly in the acicular form of rhabdite, is more abundant than in the generality of the meteoric mass.

An analysis of tænite which was dissolved in copper-ammonium chloride gave:

Fe	Ni	Co	Cu	P	
66.46	30.28	0.68	0.32	0.30	=99.69

In composition as well as in physical aspect (thin, tin-white, flexible lamellæ) this agrees very closely with the group rich in nickel and free from carbon of Toluca, Wichita, etc., as given by Cohen. With Toluca also it agrees in the presence of a determinable amount of copper. The phosphorus of the above analysis indicates, as Professor Cohen has remarked, that schreibersite is not wholly insoluble in copper-ammonium chloride.

Two analyses of cohenite were made, No. 1 being the free grains from the general solution of the mass and No. 2 the vein matter. Both were dissolved in copper-ammonium chloride and the percentages calculated for the difference in weight after deducting the considerable residue of undissolved schreibersite, separated from the carbon, which was determined by burning in a stream of hydrogen and weighing as carbonic acid:

	Fe	Ni + Co	P	C	
1.	92.88	1.33	0.48	5.33	=100.02
2.	91.67	2.43	0.09	6.07	=100.26

The phosphorus is undoubtedly due to a slight action of the solvent on the schreibersite, which is not wholly insoluble in the copper-ammonium chloride. This result agrees very well with the analyses of cohenite given by Weinschenk and Cohen, and with an unpublished analysis of that of Bendego by Dafert. In appearance the cohenite grains agree with those of Bendego although they are richer in inclusions of tabular schreibersite. Owing to the general distortion of the crystals and the rounded character of the faces no measurements could be made, but the forms are undoubtedly identical with those of Bendego, on which Hussak succeeded in demonstrating that they belong to the cubic system.

Three distinct forms of iron and nickel phosphide occur, which, although differing greatly in appearance and somewhat also in chemical composition, are probably different phases of a single mineral species. The most abundant individually are the acicular forms known as rhabdite, though, owing to their minute size, they do not equal in weight the granular and tubular forms known as schreibersite. Both are generally distributed throughout the mass, the schreibersite form being particularly abundant, included in, or adherent to, the surface of the cohenite grains, while the rhabdite needles are especially concentrated in the less soluble metallic portions and in the spongy, coal-like particles. Both are distinctly crystalline and may occur in the same individual. As Cohen has already shown the chemical identity of the two types, no further proof seems necessary that schreibersite and rhabdite belong to the same mineral species, for which the former name, being the older, should be retained. Diligent search was made without success for crystals that would admit of measurement, the rhabdite individuals being too minute and those of the schreibersite type too much distorted and with strongly rounded faces. The general appearance of the latter type is strongly suggestive of distorted crystals of the cubic system. On crystals which will be described later, separated from the Sao Francisco do Sul mass, Dr. Hussak succeeded in proving that the crystalline form of schreibersite is really tetragonal.

The third form of phosphide occupies the center of the vein mass, being inclosed between walls of cohenite. This is massive and extremely brittle, breaking with a conchoidal fracture and in color and general appearance strongly resembling arsenopyrite. The cohenite of the walls of the vein also forms a massive crust covered, however, with crystalline faces on its outer surface. As shown by the analysis below, No. 3, the composition differs from that of the typical schreibersite of the same meteorite in the relative proportions of the iron and nickel. The phosphorus is also higher in the complete analysis and approaches more nearly to what Professor Cohen considers as the normal proportion, but in a separate determination (No. 4) the proportion is nearly the same as in the normal granular schreibersite with a slight admixture of rhabdite needles, Nos. 3 and 4 of the vein matter. In all the material was freed from tænite and cohenite by treatment with copper-ammonium chloride, and in No. 2 special care was taken in the washing to make sure that the copper found in 1 and 3 previously executed, really belonged to the substance and did not come from this solvent:

	P	Fe	Ni	Co	Cu	Sn	
1.	12.82	54.34	31.48	0.67	0.20	0.00	=99.45
2.	13.17	51.25	33.68	....	0.17	1.18	=99.45
3.	14.58	66.72	17.54	....	0.13	trace	=98.97
4.	12.98						

The most reliable published analyses of meteoric phosphide, or phosphides, show very variable relative proportions of iron and nickel and cobalt even in the same meteoric mass and as regards phosphorus, a larger group with about 15 to 16 per cent and a small group with about 12 to 13 per cent. The above analyses place Cañon Diablo in the latter group. Copper is only reported in two, Schwetz and Seelasgen, both of which have been reanalyzed by Cohen with very different results and without copper, which possibly, however, was not looked for. Tin has not been reported, possibly because the solution has usually been made in aqua regia in which it would only appear through a special research. In the present case the solution was made in plain nitric acid and the tin appeared as oxide and was verified by blowpipe tests. The proportion in No. 3 was certainly as great as that in No. 2, but was not determined for fear of losing the

slight residue before a qualitative test could be made. Curiously enough it did not appear in Nos. 1 and 4, possibly from the accidental presence of enough chlorine in the nitric acid to dissolve the small amount of stannic oxide as fast as it formed. If this was not the case, it must be presumed that the tin does not belong to the schreibersite but to another mineral that is not generally distributed throughout the meteoric mass, so that it only appears in certain portions of the residue.

As in the course of this investigation, which was mainly undertaken for the purpose of verifying the reported existence of the diamond in the Cañon Diablo meteorite, nothing resembling that substance, or any other form of free carbon, could be detected, it was suspected that possibly the polishing effect produced by the dissolved mass and attributed to the presence of diamond dust might be due to schreibersite. Owing to the minuteness of the grains and their extreme brittleness, it is difficult to determine their hardness accurately and the figures given (7.01 to 7.22) may be too low. The means at hand were too crude for an accurate test, but apparently distinct scratches were produced on a cleavage plane of topaz and a depolishing effect on the polished face of a cut sapphire. Specimens were submitted to Mr. George F. Kunz with a request to test the hardness with more perfect appliances.

The nonmagnetic residue consisted for the most part of irregular, black, coal-like particles full of needles of rhabdite. These dissolve quietly in strong hydrochloric acid, setting free the crystals of rhabdite. In strong nitric acid under the microscope there is a rapid evolution of gas that tears the particles to pieces, scattering the rhabdite and leaving an extremely light, whitish flocculent skeleton.

In the following analysis this coaly residue was treated with strong nitric acid for a few minutes until the black color disappeared, and an attempt was made to collect the escaping gas. As, however, abundant red fumes appeared, it was concluded that the gas came from the acid and it was allowed to escape. The great deficiency in the following analysis indicates, however, that a gaseous constituent may have been set free from the substance. The heavy residue was separated by decantation and divided with the magnet into rhabdite and nonmagnetic portion consisting of rust particles and grains of sand evidently from laboratory dust, or dirt on the original rust covered surface of the meteorite. Nothing of interest that could be referred to the meteorite could be observed in it under the microscope. The light flocculent residue collected on an asbestus filter was burned and determined as carbon by collecting and weighing the gas given off. The other constituents were determined in the nitric acid solution. The numbers given below can only be considered as approximate, as the separation by decantation may not have been complete and there may have been some loss in the mechanical separation of the heavy residue. Still, after making all due allowances for defects in the process of the analysis, the deficiencies are too great to be accounted for in this manner and must be attributed to one or more undetermined constituents, possibly gaseous. The result obtained is as follows:

Fe	Ni + Co	Cr	Cu	P	C	rhabdite	non-magnetic residue	
7.11	37.47	trace	2.84	0.88	5.60	11.65	8.30	=73.85

The phosphorus can probably be referred to a partial solution of the rhabdite and the traces of chromium may perhaps indicate an admixture of daubreelite. The whitish flocculent substance giving carbonic acid on burning is very extraordinary, though something similar seems to have been observed by Tschermak (as quoted by Flight, History of Meteorites, p. 163) in the Goalpara meteorite. As a similar residue with the same aspect and behavior with acids and with strong nickel reaction in the borax bead was obtained in small quantities from Bendego, efforts are being made to obtain a sufficient amount for a careful study of this curious substance.

The nonmagnetic residue of the above analysis contained all the nonsoluble and nonmagnetic residue of the original mass treated, together with all the dirt accumulated throughout the long process of treatment. Nothing of interest that could not be referred with almost absolute certainty to the latter source could be observed in it in a careful microscopic examination. Evidently the mass treated did not contain diamonds or anything remotely suggestive of them.

Extended explorations were made at the locality by Messrs. Barringer [19] and Tilghman [20], who described their work in full. For the purposes of this catalogue an abstract given in the American Journal of Science [21] may be sufficient:

Recent papers on this subject by D. M. Barringer and B. C. Tilghman give a detailed description of the crater-like form of Coon Butte, and reaffirm with confidence the hypothesis early suggested that it was formed by the impact of an enormous meteorite falling with something like its original planetary velocity. As is well known, this region has afforded many thousand masses of meteoric iron varying in weight from a thousand pounds and more down to a few ounces, the total amount aggregating, it is stated, more than ten tons. Further, since the gentlemen above-mentioned have taken possession of the property, their search has revealed several thousand additional masses, aggregating more than a ton. The various remarkable features of the iron are too well known to need to be rehearsed here, but it is interesting to note that Prof. J. W. Mallet has found both platinum and iridium in samples of residues from solution in hydrochloric acid. Besides the iron, large quantities—a ton or more in weight—of magnetic oxide of iron have been found distributed over the surface of the rim and the surrounding plain. This "iron shale" contains nickel, iridium, and platinum, and apparently in the same proportion as in the meteorite itself, from which it is believed it was derived. Similar material, consisting of magnetite in various forms, was also found within the crater at depths varying from 300 to 500 feet. Part of this was in form of small spherules or "shale balls;" these showed a nucleus of

metallic iron with an envelope of magnetite. The character and distribution of this magnetic oxide, the latter similar to that of the masses of iron, furnished the authors with confirmation of the meteorite hypothesis as to the origin of the crater. Further confirmation is found in the large amount of minutely pulverized silica, as well as fragments of limestone, within the crater, and in the absence of volcanic rocks or volcanic phenomena from the immediate region. The meteoric masses have been found distributed over a crescent shaped area surrounding the hole and concentric with it, extending from northwest to east. Only two or three masses of the iron have been found within the crater itself. A number of borings with the diamond drill were made in the effort to locate the supposed mass or masses within the crater, one of these to a depth of over 1,000 feet. Several of them met with an obstruction of undetermined nature, which was believed to be the expected meteorite.

The meteorites of this fall are widely distributed among collections.

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CAPE GIRARDEAU.

Cape Girardeau County, Missouri.
Latitude 37° 14′ N., longitude 89° 31′ W.
Stone. Globular chondrite (Cc) of Brezina; Luceite (type 37), of Meunier.
Fell 3 p. m., August 14, 1846; described 1886.
Weight, 3 pieces, two of which weighed 2,058 grams. Assignable weight, 2,358 grams (5 lbs.).

This meteorite has been chiefly described by Dana and Penfield,[1] as follows:

This stone was obtained by Dr. Otto Lugger, of Baltimore, when he was residing in St. Louis, about the year 1875, from an acquaintance by the name of Padberg, whom he had employed to collect for him various objects in natural history, minerals, etc. According to Padberg's statement the meteorite had formed part of his mineral collection since 1847. It was provided with a label which stated that it fell at 3 o'clock on the afternoon of August 14, 1846, accompanied by a loud report, upon a small farm belonging to an Englishman named William Free. This farm lay some 7.5 miles south of Cape Girardeau in southeastern Missouri. The meteorite was given to Padberg by Free in 1847. It was further stated that the meteorite broke upon its fall into three pieces, two of which form the mass here described, and the third was polished and presented by Dr. Lugger to Professor Uhlberg.

The account of the history of the stone is so complete and circumstantial as to make it appear worthy of confidence, notwithstanding the many years which have passed since the stone fell.

The stone, which became the property of the Yale Museum, consisted of two parts fitted closely together, and the fractured surface between them was fresh except for the oxidation of the iron. The general shape of the stone was roughly rectangular with dimensions of 12 by 10 by 10 cm. The surface is smooth, with no sharp edges or angular projections. On one side the crust, which is rather thick, shows with remarkable distinctness the lines of flow diverging from what was probably the projecting point in its flight through the air; on what was presumably the rear side the crust is thicker, rather rough, and somewhat cellular or slaglike. One portion of the crust is simply blackened over without having a distinct crust, as if a part had been broken off shortly before it struck the ground. The general color of the fresh surface is light gray except as it is stained by the rusting of the iron; this oxidation has proceeded rather far, as might have been anticipated, and, indeed, the appearance of some portions suggests that there may have been present also some deliquescent compound (e. g. iron chloride). The mass as a whole is somewhat porous and easily fractured.

The metallic particles which have mostly a bluish tarnish are scattered very uniformly through the whole mass. The chondritic character is distinct though not strongly marked, yellowish-white spherules of olivine, and others of a dark gray (bronzite) are sparingly scattered through it; for the most part it appears to be granular crystalline.

In the sections examined under the microscope the olivine is seen in granular form, not often distinctly grouped in chondrules; the bronzite also in longitudinal fragments. The dark-gray chondrules have an indistinct fibrous eccentric structure and act rather feebly on polarized light—they may be also bronzite. The fel dspar is not particularly distinct, although occasional patches of a dull gray in polarized light probably belong here. Glassy matter is not distinctly observed.

Analysis by Penfield.

The analysis of the iron gave:

Fe	91.93
Ni	7.39
Co	0.63
Cu	0.05
	100.00

The analysis of the remaining portion yielded:

Soluble in HCl	Troilite	6.95
	Silicates	42.68
Insoluble, including chromite		50.19
Water		0.58
		100.40

The soluble and insoluble parts gave further:

	Soluble		Insoluble	
SiO_2	15.50	36.32	28.00	55.79
Al_2O_3	trace	.....	2.78	5.54
FeO	9.52	22.31	3.97	7.91
MgO	17.17	40.23	11.87	23.65
CaO	.....	.....	1.68	3.35
Na_2O	0.12	0.28	0.93	1.85
K_2O	0.02	0.04	0.12	0.24
P_2O_5	0.35	0.82	.....	.....
Chromite	.....	.....	0.84	1.67
	42.68	100.00	50.19	100.00

The composition of the first portion corresponds very closely to a ferruginous olivine, the ratio of silica to bases being 1: 2.17. The insoluble part is evidently for the most part bronzite, with probably a little feldspar, to which the alumina and soda and most of the lime belong.

This stone belongs to a rather common type of meteorites, the light-gray chondrites. The chemical analysis shows a relation of native iron to troilite and silicates very near that of the Utah meteorite, namely, 17.90 to 82.10 per cent.

Specific gravity, 3.67.

Brezina [2] classes the meteorite as a spherical chondrite (Cc) and describes it as follows:

Cape Girardeau is not very rich in chondri, quite strongly rusted, and not very friable.

The stone is principally preserved in the Yale collection.

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CAPE YORK.

Greenland.
Latitude 76° N., longitude 75° W.
Iron. Medium octahedrite (Om) of Brezina.
Recognized as meteoric, 1895.
Weight, reported but not published, 34,500 kg. (76,000 lbs.).

This fall, consisting of three large masses of iron, was discovered by Lieutenant Peary, U. S. Navy, in May, 1894, on the shores of Melville Bay, 35 miles east of Cape York, Greenland. He has given an elaborate account of the occurrence, of which the following is an abstract:

Nothing is known with regard to the fall of the masses except that the Eskimos of the region regarded them as Heaven-sent, and named them the "woman," the "dog," and the "tent," possibly from their original form, and formed a legend which represented the woman as the owner of the dog and both as abiding in the tent. Captain Ross found the Eskimos of Smith Sound using iron for knife blades and harpoon points, and learned of a supposed iron mountain from which these implements were derived. The discovery of this supposed iron mountain became an object of every polar expedition from that time on, until Lieutenant Peary, guided by a native named Tellikotinah, located the source of the iron used by these Eskimos and discovered that it was of meteoric nature.

The two smaller masses, the "woman" and the "dog," were found lying loosely on gneissose rock, on the south slope of a mountain, 80 feet above high-water mark, and about 90 feet apart. These two were secured by Lieutenant Peary without much difficulty in the summer of 1895. The "tent," the largest of the three "Saviksue" (great irons), was found on an island about 6 miles south of the site of the other two, lying nearly buried in the rock and soil, about 80 feet above high-water mark and back about 100 yards from the water line. Two unsuccessful attempts were made to remove this in 1895 and 1896, but it was finally secured in 1897 by dint of great labor and perseverance on the part of Lieutenant Peary.

The smallest of the three, the "dog," measures 27.5 by 19.5 inches and has an ellipsoidally rounded form. Its weight was estimated by Peary at 1,000 pounds.

The next larger, the "woman," measures 4 feet 3 inches by 3 feet 3 inches by 2 feet, and has an irregularly rounded trapezoidal form. Its weight was estimated by Peary at 6,000 pounds.

The larger mass, the "tent" of the Eskimos, or "Ahnighito," as Lieutenant Peary fancifully christened it (after his little daughter who was born in the Arctic regions), measures 11.2 by 7.6 by 6 feet in size. It has a very irregular shape, one end being rather square and bluff, the other tapering to a point; one side of a massive wedge shape, the other tabular and having a pronounced dorsal fin rising from it. It was found buried wedge side down, with the tabular side nearly parallel to and a foot below the surface, with only the dorsal fin projecting. Its weight was estimated by Peary at from 90 to 100 tons. Ward[2] reports, however, a careful estimate from measurements as giving a weight of 46⅓ tons.

The exposed part of the large mass was of the color of weathered bronze, with Widmannstätten figures showing in relief upon the surface in places. Much of the exposed portion showed scales of rust from the water of melting snows on the mountain above.

The surface of all three masses is in general of a dark-brown color interspersed with greenish bits, and thus resembling bronze. Megascopically the metal in all three seems the same—like a dense, tough, soft, fibrous iron or mild steel, with a silvery luster, and resonant as a bell. The masses appear to be absolutely homogeneous throughout; can be scraped with a knife, and when cut with a file show a bright, silvery luster. The etched surface shows characteristic Widmannstätten figures.

The topography of the region, as well as the character of the irons themselves, shows them to be meteorites, and not telluric iron, such as that of the Ovifak irons of Nordensjöld on Disco Island. There are no indications of any similar masses in the region for miles around; the whole country being of a gneissose character, with no signs of igneous or basaltic rocks in sight.

The "woman" was apparently the softer of the three masses and was most used by the natives for their weapons. A great pile of broken trap cobblestones lying around the site of this mass indicated that here the Eskimos came with these stones as hammers to break off pieces of the tough metal. Only about a dozen such stones were found around the "dog" and none around the largest mass. As shown by their occurrence and similarity of etching figures and analysis, the specimens belong to one and the same fall, and there are probably no others of the fall to be found, since the sharp eyes of the Eskimos would have doubtless found them ere this had such been the case.

Analysis by Professor Whitfield of the American Museum of Natural History:

	"Dog"	"Woman"	"Tent"
Fe	90.993	91.468	91.476
Ni	8.265	7.775	7.785
Co	0.533	0.533	0.533
Cu	0.016	0.018	0.014
S	0.019	none	none
P	0.172	0.188	0.202
C	0.014	0.070	0.023

All the masses are in possession of the American Museum of Natural History.

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Capitan. See El Capitan.

Carleton. See Tucson.

CARLTON.

Hamilton County, Texas.
Here also Hamilton County and Carlton-Hamilton.
Latitude 31° 55′ N., longitude 98° 2′ W.
Iron. Fine octahedrite (Of) of Brezina; Carltonite (type 22) of Meunier.
Found 1887; described 1890.
Weight, 81.5 kgs. (179 lbs.).

This meteorite was first described by Howell [1] as follows:

In April, 1888, while plowing in his field, about 5 miles south of Carlton, Hamilton County, Texas, Mr. Frank Kolb struck with his plow what he at first supposed was a stone, but which proved to be the meteorite in question. Whether or not he had any idea of its true nature does not appear, but he seems to have kept it about a year before engaging a Mr. St. Clair to sell it for him.

It measured 17.5 by 13 inches (44 by 33 cm.), and weighed 179 pounds (81.5 kg.), and was entire except for a few ounces cut off for analysis. The thinner end had been pounded considerably, however, and some small fragments may have been detached, so that its original weight may have been 180 pounds.

It is roughly conical in form, the under side or base being smoother and less sharply pitted than the upper side, which was probably the forward end in its flight through the earth's atmosphere. Although very little oxidized, it shows none of the striæ and ridges characteristic of a recent fall.

This iron etches quickly and most beautifully with a very dilute acid. Where the plessite is most abundant the figures resemble somewhat the markings on the Trenton and Murfreesboro irons, but more closely those of the Descubridora. The lines of kamacite are narrower, however, than in any of these irons, and the inclosed figures smaller and more elongated, being in many parts a mere thread 5 to 8 mm. in length; but in this respect different parts of the same section vary greatly. Some of the inclosed figures are beautifully marked with the fine lines first noted by Dr. J. Lawrence Smith on the Trenton iron, and called by him Laphamite markings. These mostly disappear when the iron is deeply etched.

Analysis (Eakins):

Fe	Ni	Co	Cu	S	P	C	
86.54	12.77	0.63	0.02	0.03	0.16	0.11	=100.26

Specific gravity, 7.95 at 27°.

Meunier [3] described the structure as follows:

The resemblance of this stone with that of Laurens Court House is very close. The principal difference consists in the presence of pyrrhotine in quantity, which fills the cracks of the mass which was broken under mechanical strain, following the direction of the orientation of the constituent alloys. A further result is that the sulphureted accumulations upon the sections are spindle-shaped. Very small grains of schreibersite appear here and there in the mass of carltonine.

Brezina [4] in his 1895 catalogue described the iron as follows:

The Carlton iron is one of unusual variety of structure. The exterior is tolerably fresh, showing numerous semicircular depressions 1 to 1.5 cm. in size, formed doubtless by the fusing out of troilite. These are filled to the depth of one or two thirds of their capacity with bright gray, mostly concentrically arranged, fused iron. On such places the iron often glistens to a depth of 5 to 10 cm. In one place a crack, filled with limonite and magnetite, extends from the outside to the interior, apparently in the place of a great schreibersite crystal. Likewise there is to be seen upon only one portion of the exterior an octahedral facet, exposed by weathering. The laminæ are mostly long and unevenly notched, 0.2 mm. thick, and straight; only upon one small side upon which the iron struck the ground is there to be found a more marked swelling, caused by bending, and the laminæ are correspondingly strongly bent. The fields are sometimes very fully developed, almost as in the case of Butler, and sometimes with the bands in equal proportion, but occasionally are almost entirely wanting. When the fields predominate they are usually filled with dark-gray plessite, which shows distinct, glistening points; not infrequently there is found in the midst of such an area a central, half-blended skeleton often reduced to extreme fineness, which is either connected with the borders of the field with a few laminæ running outward or else apparently lies free in the plessite. Occasionally instead of

the central skeleton we find a half-blended secondary skeleton near the border of the field, yet divided from this by plessite. The secondary laminæ are sometimes bunched, but do not run in comb fashion from the border of the field toward the middle. In places where the fields disappear and a coarse band structure prevails, numerous Reichenbach lamellæ from 5 to 10 mm. long occur, which consist of lumps of troilite, for the most part composite, seldom individual, arranged in planes and enveloped in kamacite 0.2 to 0.4 mm. thick. Of rare occurrence are isolated points of cohenite in the laminæ. Huge inclusions of schreibersite, for the most part bordered by crystal facets and inclosed by finely hatched kamacite bands 0.5 to 1 mm. thick, appear, sometimes isolated, sometimes united into groups and bunches, and attaining a length of from 4 to 6 cm., sometimes even from 10 to 12 cm. Round about such a colony of schreibersite crystals the fields predominate in a striking manner. Not infrequently occur troilite grains or crystals, sometimes quite regular in outline, sometimes fresh, sometimes limonitized, mostly 1 to 1.5 cm. in size, with a corona of schreibersite crystals from 2 to 8 mm., enveloped in swathing kamacite. Curving of the Widmannstätten figures is frequent on the larger cavities of the exterior. The curving follows the cavity like an onion skin along the octahedral laminæ and transverse cracks between such.

Cohen [5] made the following additional observations:

For Carlton change in structure is especially characteristic. Here and there the fields are large and numerous so that the plessite largely predominates; in other parts the plessite varies and bands are in about equal proportions; and finally the latter may be so predominant that the fields, both in size and number, almost disappear. The bands consist of fine-grained kamacite and are long, straight, and often grouped, in part equal and in part unequal, and the groupings are the more abundant the more the plessite is subordinate; here also the bands seem to be finer. Brezina gives the breadth of the lamellæ in cross section as 0.2 mm. The tænite appears in relatively broad ribbons and unusually sharp, like to Laurens, and adds considerably to the beauty and delicacy of the appearance of the etched surface. The plessite is dark gray and compact, homogeneous in the smaller fields, and in the larger sparkling from little shiny tænite flakes which are quite often arranged in zones. With them often appear central skeletons whose intergrowth with the edge of the fields was observed by Brezina. Combs seem to occur quite scatteringly. The richness in great schreibersite crystals is an important feature. On a plate in the Vienna Museum, measuring 300 sq. cm., one sees thirteen groups of crystals some of which reach a length of 4 cm. In a plate figured by Howell the number is smaller but the individuals reach, as stated, a length of 15 cm. From the form of the sections it would appear that the crystals are numerously bounded by faces. The schreibersites are surrounded by swathing kamacite which often attains a considerable breadth, and according to Brezina is not granular like the kamacite in the bands, but finely hatched. In the neighborhood of many crystal groups the structure through the increase in size and number of the fields is coarse-meshed. Troilite occurs sparingly. It appears almost wholly only in short Reichenbach lamellæ, which exceptionally reach a length of 5 to 10 mm., and which according to Brezina as a rule are connected, although at times isolated. They are arranged in planes surrounded by the swathing kamacite 0.3 to 0.4 mm. thick and seem to be very unequally distributed. Brezina mentions point-like cohenite occurring rarely in the bands; Farrington troilite in radiated veins; and I observed troilite and graphite in some well-formed crystals. In many places the octahedral lamellæ are dislocated. According to Brezina the dislocation follows onionskin-like concavities on the surface along octahedral lamellæ and swellings between them. In the neighborhood of the natural surface a strong bending of the lamellæ has occurred on one side of the mass, which indicates that the block here struck the earth. Leick determined the specific gravity as 7.8542 at 20.6° C. According to him the iron takes pretty strong permanent magnetism—5.82—and possesses a specific magnetism of 5.76 absolute units per gram.

The meteorite is distributed, Vienna possessing 6,986 grams, London 6,185, Ward 5,592, Chicago 3,406.

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Carroll County. See Eagle Station.

CARTHAGE.

Smith County, Tennessee.
Here also Coney Fork, Carthago, and Karthago.
Latitude 36° 15′ N., longitude 86° 5′ W.
Iron. Medium octahedrite (Om) of Brezina; Caillite (type 18) of Meunier.
Found 1840; described 1846.
Weight, 127 kgs. (280 lbs.).

This meteorite was first described by Troost.[1] He states that he obtained a piece through Samuel Morgan, of Nashville, and learned from him that the mass was found in 1844, about a mile from Carthage. It was thought by the finders to be silver. It was an oblong, shapeless mass, its surface showing here and there some projecting octahedral crystals. Etching developed Widmannstätten figures. The iron was tough and malleable and contained no secondary minerals.

No further important study seems to have been made of it until 1866, when Boricky[9] published a description and analysis, as follows:

Study was made of a polished section in the Prag Museum, labeled Karthago, North America. The piece weighed 1.8 kgs. It was covered with a limonite crust from which obscure crystal fragments projected. The crust separated easily from the iron mass and pulverized to a reddish brown powder in which little angular silver-white flakes [called by the author schreibersite] could be seen. Besides the iron content the powder contained oxide of nickel, sulphuric acid, silica, and traces of cobalt, earthy alkalies, phosphoric acid, and chlorine. The interior of the iron mass was highly crystalline, tough, and malleable. It dissolved very slowly in dilute HCl without noticeable odor. In dilute HNO_3 it dissolved rapidly. The specific gravity of two pieces gave 7.5 and 7.478. The analysis gave:

Fe	Ni	Co	P	S	Si	Cl	X	
89.465	7.721	0.245	0.093	0.401	0.602	trace	1.192	=99.719

X represents residue insoluble in dilute nitric acid. This consisted of silver-white flakes, a black substance (graphite), and traces of silica. In another part of the residue traces of chromite were found and microscopic fragments of a white transparent body. The section is cut on three sides but polished on only one face. The polished and etched surface shows shining yellowish white lines of tænite which in some places consist of compactly arranged points and inclose groups of faces mostly regularly bounded by tænite lines. Of these smaller faces, which are irregularly triangles, rectangles, parallelograms, and trapeziums, the majority are penetrated by fine tænite lines and a few are filled by a lusterless dark-brown mass which shows strong resistance to the action of acid. On the polished surface the tænite lines run in four different directions and cross at angles of 90°, 70°, 110°, and 20°, while on the side faces only three directions can be seen. In the fields not inclosed by tænite lines there can be seen with a lens flakes and flat grains of silver-white color (schreibersite) which appear to be mingled with the groundmass. Occasionally on the polished face occur dark brown masses of irregular shape (troilite) which are generally bounded by fine tænite lines. Finally, the polished face shows round and elongate depressions probably due to removed troilite.

Brezina,[15] in his 1885 catalogue, gives the meteorite the name Coney Fork (Carthago) and describes it as follows:

Coney Fork resembles Charcas in the numerous specks of troilite, which, however, are embedded in kamacite. It is finely flecked like Rancho de la Pila. The kamacite is not so distinctly bunched as in the case of the first three irons of the group (Caille group), but is somewhat puffy. Bands 0.8 mm. wide.

Huntington,[17] in his 1897 catalogue, gives the name Coney Fork, Carthage, and lists eleven slabs and masses as being in the Harvard collection. The largest, weighing 9,980 grams, he describes as follows:

Large mass of cleavage octahedrons, with sharply defined faces and edges, packed together like an aggregate of large crystals of alum.

Another specimen weighing 932 grams he describes in detail as follows:

This specimen shows six faces of a rough octahedron, one of the faces having an area of 7 square inches. One-half of this octahedron has been partially torn apart into numerous smaller crystals, some of them an inch or more in diameter; but though the crevasses between the individuals are in some places nearly a quarter of an inch in breadth, yet they are bound firmly together by a network of plates, which in some parts raggedly jut out from the octahedral faces. The general appearance of the exterior of the specimen reminds one somewhat of a rough mass of galena crystals, only of octahedral form. The rough crystal is evidently the result of fracture, probably caused during the passage of the mass through the air, and the octahedral faces are cleavage planes, if the term cleavage may be applied to such fractures, which can not be reproduced by splitting in the ordinary way on account of the malleability of the mass. The specimen further exhibits a fused crust over the octahedral faces, which must have formed after the partial breaking

up of the large mass, giving a rounded appearance to the edges. On a polished surface, cut nearly parallel to the largest octahedral face, the figures produced by etching appear very strikingly. They are perfectly distinct and regular, being typical Widmanstättian figures; but when they come to the cracked portion of the iron, they appear as separate plates, some having been broken by the rupture, others separated, while the greater number appear bent and strained, but still coherent, and binding the mass firmly together. The whole appearance of the etched surface gives at once the idea of a forcible explosion, and yet all the cracks, even the most ragged, follow directions parallel to the octahedral faces.

Meunier [18] gives the following account:

The Carthage iron presents in great perfection the typical structure of the type. The kamacite is finely grained and the plessite has a shagreened appearance. Small masses of pyrrhotine may be seen in some interstices of the alloys.

This iron has suffered confusion of names with that known as Smithville. This is because it has been sometimes known by the name of Coney Fork, which has been mispelled Caney Fork, and this in turn has been confounded with Caryfort, another name of Smithville. The two irons are, however, different in character and the localities are many miles apart. The name Carthage has also been mispelled in foreign catalogues so as to become Carthago, which is Wülfing's and Brezina's name. Berwerth has made this worse by calling it Karthago. The name originally given by Troost, however, Carthage, is correct and accords with the best usage.

The iron is distributed, the largest pieces being possessed by the British Museum (24 kg.), Tübingen (64 kg.), and Harvard (18 kg.).

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Carthago. See Carthage.

Caryfort. See Smithville.

CASAS GRANDES

Chihuahua, Mexico.
Latitude 30° 27′ N., longitude 107° 48′ W. (28° 40′ N., 106° 25′ W., Berwerth).
Iron. Medium octahedrite (Om) of Brezina.
Prehistoric; described 1867.
Weight, 1,545 kgs. (3,407 lbs.).

The meteorite from Casas Grandes was first mentioned by Tarayre.[1] According to him the director of the mint, Müller, of Chihuahua, found the meteorite while excavating the temple ruins of Casas Grandes, in Chihuahua, in a labyrinthine room near the surface. It was a lenticular shaped mass of meteoric iron with a diameter of 50 cm., which was incased in wrappings similar to those surrounding the bodies in the neighboring graves.

Burkart[3] added that the mass was in the possession of Müller in 1870. In 1873 Mr. William M. Pierson, U. S. Consul at El Paso, in a letter to the State Department[4] gave an account of the find which differs both as to the discoverer and as to the person into whose possession the mass came. According to Pierson, the inhabitants of the small town of Casas Grandes (240 km. south of the Paso del Norte) searched the neighboring ancient temple ruins of the "Montezuma Casas Grandes" for treasure, and found, in the middle of a large room, a sort of grave with an immense block, estimated at 5,000 pounds weight, carefully wrapped, like an Egyptian mummy, in a coarse linen cloth. The Casas Grandes was the dwelling place of the Montezuma Indians, and accordingly the entombment of the meteorite took place before the conquest of Mexico by the Spaniards. The block was first brought, he says, to the little town of Casas Grandes and placed in the street before the house of the finder, Alverado by name, from whom it was purchased, years afterward, by Pierson and some others. Together with Pierson's report a piece of this meteorite came into possession of the Smithsonian Institution in 1873.

Nothing further was heard from the mass until 1876, when the Smithsonian Institution came into the possession, by gift, of an uncut mass of meteoric iron which had been exhibited among the Mexican minerals at the Centennial Exposition.[5]

The possession of this by the National Museum was recorded by Clarke,[6] in the catalogue published in 1886, as an uncut mass from Chihuahua, Mexico, weighing about 1,800 kg. Fletcher[7] suggested that this was probably the Casas Grandes mass.

In 1902 Tassin[8] published the first detailed description of the mass, of which the following is a résumé:

The iron is lenticular in shape, 97 by 74 by 46 cm. in size, and weighing (uncut) 1,544.788 kg. (3,407 pounds). The outer surface is almost entirely covered with broad shallow pittings, some of them quite large. The surface is more or less oxidized and does not differ from the so-called "crust-surface" of other meteoric irons, containing little or no ferrous chloride. The iron works readily, having the hardness of ordinary steel and the toughness of low-grade nickel steel. A polished surface (55 by 38 cm.) showed a few small grains and nodules of troilite, the largest not over 2 cm. in diameter, and the smaller and more numerous not larger than a pinhead. No schreibersite, carbonaceous nodules, or stony matter is visible on the polished surface; etched with dilute nitric acid it develops a beautiful crystalline structure. Seen by reflected light, the surface shows numerous fine lines of a yellowish to tin-white color which was found to be schreibersite; this is generally arranged lineally and is usually to be seen only by reflected light, although occasionally it stands out in relief.

Several analyses were made to determine whether the nickel-cobalt contents were constant or not, with the following result:

	a	*b*	*c*
Ni	4.38	5.02	4.50
Co	.27	.30	.00

These figures show a wide variation in composition in different parts of a mass, the character of whose etching figures is such that it would be supposed that the iron was fairly uniform. Accordingly, Tassin concluded that a safer guide to the composition of the mass could be obtained by separating the different minerals. He did this with the following results:

	Fe	Ni	Co	Cu	C	P	S	
Total	95.13	4.38	0.27	trace	trace	0.24	0.00	=100.02
Troilite	63.49	0.20	....	.....	.....	.....	36.21	= 99.81
Schreibersite	64.69	20.11	....	.....	.....	15.00	.....	= 99.80
Tænite	82.90	16.64		0.04	.....	0.09	.....	= 99.67

The troilite was of a brass yellow to bronze color, hardness about 4, specific gravity 4.789, slightly magnetic. Graphite commonly occurred as a thin layer between the troilite and the iron. The analysis was made on a nodule weighing 1,529 grams. The schreibersite occurred in part evenly distributed over the mass in fine, hair-like lines and thin plates, never in nodules, and the bands seldom distinct enough to show in a photograph of an etched surface. Their arrangement agreed with that of the general structure of the iron, and was so similar to the tænite bands as to be readily mistaken for them. From 150 grams of nickel iron 1.21 grams of schreibersite, specific gravity 7.123, was obtained. It consisted of shiny, magnetic, steel gray, very brittle scales and grains; a portion of the latter failed to dissolve in nitric acid and appeared to be surrounded with a colorless, transparent, isotropic silicate, of which there was not sufficient for a closer determination. The tænite occurred in thin lamellæ.

Since the content of nickel and cobalt obtained by Tassin was considered unusually low for an octahedrite, a section of 83.5 grams was investigated by Cohen.[9] His results are as follows:

Casas Grandes is an octahedrite with lamellæ of medium breadth. The granular, usually elongated, only occasionally somewhat tumid, bands are abundantly and distinctly hatched and, at least after moderate etching, very poor in etching pits; despite this the oriented luster is very lively. The tænite stands out distinctly. According to Tassin a part of the lamellæ which appear like tænite, and occur in a similar form, are composed of schreibersite, but no ground for this opinion is given. I repeatedly examined the lamellæ with a glass and a fine steel needle, and all proved to be ductile. Accordingly they could not be related to the brittle schreibersite. The greater part of the comparatively numerous areas consist of granular kamacite whose color corresponds with that of the bands. The grains of slightly varying dimensions attain a size of 0.1 mm. Tænite is distinctly lacking in the plessite; only occasionally is a granule or scale of lighter color and smoother, more lustrous etching surface observed, which is too small to determine whether it is composed of tænite or schreibersite. A few other areas are constituted of slightly hatched, parallel kamacite pencils 0.1 to 0.2 mm. thick, between which tænite is occasionally distinctly seen.

The analysis by Hildebrand and Cohen [9] gave the following results:

Fe	Ni	Co	Cr	P	S	Chromite	
92.66	7.26	0.94	0.03	0.18	0.02	0.03	=101.12

The composition is accordingly normal for an octahedrite rich in tænite. The comparatively small content of phosphorus also counts against Tassin's assumption that schreibersite occurs abundantly in the form of tænite.

From the above figures we get the following mineralogical composition of the sample investigated:

Nickel iron	98.79
Schreibersite	1.16
Troilite	0.05
	100.00

The meteorite is chiefly (1,318 kgs.) in the possession of the United States National Museum.

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CASEY COUNTY.

Casey County, Kentucky.
Latitude 37° 15′ N., longitude 95° W.
Here also Casey County, Georgia.
Iron. Coarsest octahedrite (Ogg) of Brezina; Bendégite (type 6) of Meunier.
Found and mentioned 1877.
Weight, assignable, 732 grams (1.5 lbs.).

The first mention of this meteorite is by Smith,[1] who simply states that he had received it as one of two new meteoric irons, analyses and descriptions of which would be published shortly after. Such publication seems, however, never to have been made. All that is further known of the meteorite consists of brief descriptions of its intimate structure by Brezina[2] and Meunier.[4] These are as follows:

A fragment in the Vienna museum shows very regular, broad Widmannstätten figures, with bands of an average width of 2 mm.; kamacite is almost exclusively exhibited, with unusually sharp etching figures; tænite and plessite only in traces, schreibersite and troilite not perceptible.[2]

Breadth of laminæ 1.8 mm. Hatching fine and distinct; fields very scarce.[3]

A very beautiful specimen of Bendégite remarkable for the extreme size of the kamacite bands, some of which measure as much as 5 mm. in width. It shows the Neumann lines in much smaller numbers than the Bohumilitz iron and has many specks of phosphides scattered over them.[4]

Wülfing[5] lists 732 grams as present in collections. Of this amount the Harvard collection possesses the largest section.

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CASTALIA.

Nash County, North Carolina.
Here also Nash.
Latitude 36° 11′ N., longitude 77° 50′ W.
Stone. Brecciated gray chondrite (Cgb) of Brezina; Canellite, (type 48) of Meunier.
Fell 2.30 p. m., May 14, 1874.
Weight, 73 kgs. (16 lbs.).

This meteorite was first described by Smith[1] as follows:

The meteorite of Nash County, North Carolina, fell May 14, 1874, at 2.30 p. m., near Castalia, in latitude 36° 11′ N., longitude 77° 50′ W. Its fall was accompanied by the successive explosions common in such cases, and with rumbling noises which lasted about 4 minutes, not unlike the discharge of firearms in a battle a few miles off.

The stones that fell must have exceeded a dozen or more; three only have been found, and they give evidence that the territory over which the fragments fell was 10 miles long by over 3 miles wide. Although occurring in the day the body appeared luminous to some observers. The three stones found weighed respectively 1 K., 800 grams, and 5.5 K.

They are of common aspect. They have a dull exterior coating, which in some places does not entirely cover the stones, there being a few spots of the fractured surface, less than 1 cm. in diameter, over which the fused matter forming the coating is scattered in the form of pear-shaped beads. In one or two crevices some of the fused matter of the coating has penetrated 5 mm. below the surface.

The interior in many parts is of a dark gray color, and in other parts quite light; the principal cause of the dark color is doubtless the larger amount of nickeliferous iron in that part, and in the lighter portion there are some white spots of a mineral that is doubtless enstatite.

The specific gravity of the stone is 2.601. Its composition is as follows:

Nickeliferous iron	15.21
Stony minerals	84.79

The nickeliferous iron consists of:

Iron	92.12
Nickel	6.20
Cobalt	.41
Copper and phosphorus (not estimated).	
	98.73

The stony portion consists of:

	Insoluble, 47.02.	Soluble, 52.98.
Silica	52.61	38.01
Alumina	4.80	.46
Protoxide of iron	13.21	17.51
Magnesia	27.31	41.27
Sulphur	.....	1.01
Alkalies (soda with traces of potash and lithia)	1.38	.....
	99.31	98.26

The mineralogical examination and chemical analysis indicate that the stone consists essentially of nickeliferous iron, bronzite, and olivine with small particles of anorthite and enstatite.

In his 1885 catalogue Brezina [2] describes the meteorite as follows:

Shows deep-blue linear troilite, white fragments in a dark gray groundmass and isolated, jet black grains of the size of mustard seed with very fine particles of iron scattered throughout.

In 1895, Brezina [3] described a large individual as follows:

An almost uninjured monolith of 5.2 kg. in the Hidden collection has the form of a six-sided prism covered partly with large pittings, partly with a very even crust, with a fractured surface in one place which shows the brecciated structure of the interior.

Meunier [4] describes a Paris specimen as follows:

It is remarkably coherent and compact and forms an intermediate link between limerickite and stawropolite, which may be regarded as the metamorphic form.

The meteorite is distributed.

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4. 1897: Meunier. Révision des pierres météoriques, p. 81.

CASTINE.

Hancock County, Maine.
Latitude 44° 24′ N., longitude 68° 46′ W.
Stone. Veined white chondrite (Cwa) of Brezina; Lucéite (type 37, subtype 2) of Meunier.
Fell 4.15 a. m. May 20, 1848; described 1848.
Known weight, 93 grams (3 ounces).

Our knowledge of this meteorite is confined almost wholly to a description by Shepard.[1] He obtained from Rev. Daniel Sewall, of Castine, an account of the fall as follows:

The appearance of the meteor and the attendant circumstances, so far as I have been able to gather them, may be described as follows: On Saturday morning, May 20, about half past 4 in the morning, Mr. Charles Blaisdell, a mechanic, who lives about a mile from the village, being out of the house at the time, noticed dark clouds, apparently gathering from different quarters of the heavens. Soon he saw what he supposed to be a flash of lightning. Presently, however, upon looking at that portion of the cloud which came from the northwest, he saw what appeared like the moon in the cloud, not as at the horizon, but when high in the heavens. A sudden, sharp report like a cannon was heard, followed by a quick succession of reports not so loud as the first, but which resembled a running fire of musketry; and after these a whistling sound in the air, as of a body passing through it with great rapidity. Something was seen and heard to strike the ground in the road but a little distance from the place where he was standing, which proved to be the stone in question. Mr. Giles Gardiner also saw the stone strike the ground, but he did not notice the meteor. I could not learn from Mr. Blaisdell that the meteor had any apparent motion, except with the cloud, before the explosion. He stated that he was looking at it from 8 to 10 minutes. The report was heard by great numbers in the village and elsewhere. Some saw a streak of light.

In the same article Shepard quotes an account given by Professor Cleaveland:

It fell at Castine, Maine, 4.15 a. m., May 20, 1848. The fall was accompanied by a noise similar to thunder, but quicker and more like that of a gun. The report was distinctly heard at a distance of 30 or 40 miles from Castine. A second report, resembling the discharge of muskets, was also heard.

The stone came from the southeast, and by its fall penetrated to the depth of 2 inches into a dry, hard road. No flash of light was observed by the person who witnessed the fall, although the stone struck the earth within a few feet of him. Others assert that they saw a flash.

Its whole weight when entire was 1.5 ounces avoirdupois. The finder broke off a piece to examine the inside and threw the fragment away. It was further diminished by the portion sent to you. Its present weight is 1 oz., 3 pwts., 5 grs. The whole was invested by a black crust. Its shape was somewhat wedge-shaped, one surface being nearly plane, and the other irregular or slightly waved. The stone is now in the mineralogical cabinet of Bowdoin College, to which it was presented by Mr. Lemuel W. Atherton, of Castine, who received it from the person who observed its fall.

Shepard [1] goes on to say:

To the foregoing I have the following observations to make, derived from an examination of the fragment so obligingly presented to me for the purpose by Professor Cleaveland.

Specific gravity, 3.456. In general appearance it resembles the Poltawa stone (of March 12, 1811), but is distinguishable from that by possessing a much lighter color, a more pearly luster, and in being destitute of specks of iron rust. The nickeliferous iron is in smaller points and possessed of an unusually brilliant silver-white luster. The magnetic iron pyrites is easily distinguishable in little points though less abundant than the malleable iron. A few very fine black points are also discernible which give, before the blowpipe, the reaction of chromium; they are probably chrome-iron.

The malleable iron was separated by means of the magnet and equalled in weight 11.22 per cent of the entire stone. It proved uncommonly rich in nickel, being identical in composition with the Green County, Tennessee, meteoric iron; i. e., having

Iron	85.3
Nickel	14.7

The earthy constituent of this stone, like that of the Iowa meteorite, is decomposed by concentrated hydrochloric acid, and like it, appears to be a tersilicate of protoxyd of iron and magnesia, a mineral which, though frequent in meteoric stones, has never yet been distinctly recognized and which in a future paper on American meteorites I shall more particularly describe under the name of *Howardite*, after the Hon. Mr. Howard, that celebrated chemist, who was the first British writer whose labors contributed to elucidate the history of these extra terrestrial bodies.

No further description seems to have been given of the stone. Brezina [2] classifies it as a white chondrite.

Wülfing [3] lists 22 grams in collections, but makes no mention of the Amherst collection, which contains 29.5 grams. Ward's catalogue [4] lists 42 grams, making a total of 93 grams. Apparently Ward secured a piece not mentioned by Shepard.

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CENTRAL MISSOURI.

United States.
Latitude 37° N., longitude 93° W.
Iron. Coarse octahedrite (Og) of Brezina.
Found 1855; described 1900.
Weight, probably 25 kgs. (55 lbs.).

Existing knowledge regarding this meteorite is confined to that gathered by Preston [1] in the following:

The history of this most interesting siderite, as to the exact date when found, and the precise locality where found, has been entirely lost.

The weight of the whole was probably about 25 kg. An end piece apparently about half the entire mass, weighing 12,360 grams, has been deposited for many years in the Western Reserve Historical Society of Cleveland, Ohio, while the other half was in the collection of the late Prof. Wm. Denton, of Wellesley, Massachusetts. Through the librarian of the Western Reserve Historical Society, Prof. J. P. MacLean, Professor Ward has obtained a large portion of this piece.

The outer surface of the mass is most beautifully and typically pitted, and of a dark reddish-brown color, with the exception of the prominent ridges, which are of a lustrous dark steel-gray color, resembling graphite, although it does not soil paper when rubbed over it.

On cutting the mass we found numerous fissures meandering in various directions over the entire surface. A few of the largest are 1 mm. in diameter, and are filled in part by a black graphite-like substance, and in part by schreibersite. There are also patches of schreibersite, resembling hieroglyphics, some of them 5 by 25 mm. in diameter, scattered here and there over the surface. A few prominent troilite nodules are visible on the sections, the largest being 9 by

15 mm. in diameter. On etching the iron no figures whatever are brought out, leaving only a minutely pitted light gray surface which is more or less clouded.

The only history of the finding of this siderite as furnished by Prof. J. P. MacLean from the records of the Western Reserve Historical Society, is as follows:

"This meteorite was found in the fifties in central Missouri, and after being cut in halves one-half went to the late Prof. Wm. Denton and the other half was purchased of Mrs. Newcomer (of Cleveland) by the late Judge C. C. Baldwin and by him presented to the society."

An analysis of this siderite (specific gravity, 7.5) by Mariner and Hoskins of Chicago gave:

Fe	Ni	Co	P	S	C	
94.734	4.62	1.18	1.442	1.015	1.009	=100.00

The small amount of carbon is probably due to the fact that the portion of the mass used for analysis was free from the black graphite-like veins.

As no more definite locality can be traced as the location in which this iron was found we will designate for this iron the name Central Missouri.

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CHAMBORD.

Lake St. John County, Quebec, Canada.
Latitude 48° 35′ N., longitude 73° 8′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1904; described 1906.
Weight, 6.6 kgs. (13 lbs.).

This meteorite was described by Johnston [1] as follows:

Some time during the season of 1904 a mass of iron was picked up in a field about 2 miles from the village of Chambord (latitude 48° 35′ N., longitude 73° 8′ W.), county of Lake St. John, Province of Quebec. It was secured by Mr. J. Obalski, superintendent of mines, Quebec, and by him kindly loaned to the Geological Survey Department for purposes of examination. It is an irregularly shaped block having a length of 18.9 cm., a thickness of about 8.9 cm., and a width varying from 10.1 cm. to 15.5 cm., and a weight of about 6.6 kg. The surface of the specimen has unfortunately to a considerable extent been marred by chisel and hammer marks made in attempts to cut up the iron. The greater portion of the original crust has been scaled off by prolonged weathering and its place taken by a thin coating of dark brown rust; that portion of the crust which is still remaining is smooth with a dull enamel-like luster and has brownish-black color; the surface is possessed of the usual pittings found on meteoric irons; some of these are broad and shallow while others again are small. A trough-like depression extends along one side of the specimen, the bed of which is more or less jagged as if a piece had been detached during the meteorite's flight through the atmosphere. Over a considerable area of the specimen a natural etching is visible, sometimes as coarse furrowings and at others as minute ridges. Etching of a polished surface develops the Widmannstätten figures in moderately coarse outline, the general design indicating an octahedral structure; this iron, therefore, belongs to the "Medium Octahedrites (Om)" of Brezina's system of classification. Schreibersite appears in considerable abundance as very thin lamellæ disposed between the kamacite plates; in the trough-like depression previously referred to two small nodules of troilite are exposed in section; they measure approximately 13 mm. in diameter and exhibit a series of fine parting lines running in parallel position. This iron has not yet been subjected to chemical analysis.

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CHARCAS.

Santa Maria de los Charcas, San Luis Potosi, Mexico.
Latitude 23° 14′ N., longitude 101° 7′ W.
Iron. Medium octahedrite (Om), of Brezina; Caillite (type 18), of Meunier.
Mentioned 1804.
Weight, 783 kgs. (1,722 lbs.).

This meteorite was first described by Sonneschmid.[1] He states that it was a half-buried block of native iron standing in the corner of a churchyard at Charcas. The part above the surface was about 2.5 feet long and 1 foot thick. He says:

It is said that the mass was brought from the neighborhood of San José del Sitio, an estate 12 leagues distant, and that in the same neighborhood several other masses have been seen firmly embedded in a limestone-like rock.

Burkart[3] practically repeats these observations as follows:

In Charcas, the large iron meteorite from the hacienda del Sitio is placed near the church as a curbstone. The projecting piece has a height of 2 feet 8 inches. The whole mass may have a volume of 1.7 cubic feet and weigh 800 to 900 pounds. The surface, showing many rounded hollows, has by rain and wind lost its natural color.

Daubrée[4] described the meteorite as follows:

The academy will doubtless be interested to know that the Mexican meteorite which four months ago Marshal Vaillant announced had been sent to France has arrived at the geological gallery of the museum. Mexico is one of the regions of the globe in which many masses of meteoric iron are known. Burkart, Councillor of Mines of Prussia, who resided a long time in the country, enumerates in a recent interesting memoir nine distinct localities.

On leaving for Mexico, I gave Marshal Bazaine a copy of this work and expressed the wish that one of these masses might be obtained for France. Honoring this request with a kindness of which the friends of science should show warm recognition, the commander in chief of the expedition corps obtained at Charcas, in the State of San Luis Potosi, the mass of meteoric iron which has lain there from time immemorial. In spite of the enormous difficulty of moving a mass of such weight it was sent to France and offered to the emperor, who kindly placed it in the museum. This beautiful mass of meteoric iron forms now in our geological gallery a worthy companion to that of Caille.

Mentioned in 1804 by Sonneschmid and seen in 1801 by Humboldt, this mass of meteoric iron lay at the northeast corner of the church of Charcas, partly buried in the soil. Charcas is a little village situated about 23° 15′ north latitude in the State of San Luis Potosi. It is 75 km. south of Catorce, and 172 km. northeast of Zacatecas, where equally large masses of meteoric iron have been found. It is said that the meteorite of Charcas was moved from the hacienda of San José del Sitio, 50 km. distant. The weight of the meteoric iron of Charcas is 780 kg. It is about 1 m. high, 47 cm. long and 37 cm. thick. The iron presents everywhere its natural surface. Its general form is that of a truncated triangular pyramid with smoothed edges. One of the most remarkable features is the nearly flat face which extends entirely across the mass. This represents what is called in Germany the front side in opposition to the rear side. One of the corners of the pyramid is replaced by a large depression 30 to 36 cm. in diameter. This is bordered by a wall nearly perpendicular to the bottom, which is 10 cm. deep. There is also a series of small depressions nearly circular in form, shallow, and resembling small cups like those seen in the meteoric stones. They are not exclusively confined to the large cup, but may be seen, though in less numbers, in other portions of the surface. Elsewhere, depressions occur reminding one of marks left by raindrops upon a soft surface, also cylindrical cavities like those in the iron of Caille. These are evidently due to dissolved troilite nodules. Their length varies from 5 to 10 mm. and their depth attains 20 mm. Like those of Caille, they are parallel and appear to have a general orientation in accordance with the crystallization. From one face of the meteorite portions have been detached, showing that the iron is of remarkable whiteness. It takes a polish easily and becomes brilliant. These polished surfaces show also frequent troilite nodules like those on the surface. Widmanstätten figures appear very neatly on the polished surfaces with acid, but they have not the regularity of those of the iron of Caille. Schreibersite appears in little isolated grains. These appear in part oriented parallel to the faces of an octahedron and in part to the faces of a dodecahedron, as is shown upon a specimen which I have cut in the form of a sphere. The action of acid makes significant planes which may be perceived on portions of the oxidized surface. These pass through the curvatures of the iron showing that they are not subsequent to the crystallization of the mass. The density of the iron is 7.71. After fusion it does not present the characteristic figures of natural iron. It dissolves in acid rather slowly. The solution is accompanied with the disengagement of hydrogen sulphide, showing decomposition of the iron sulphides. A residue of 0.2 per cent is left and the solution contains principally iron and nickel. Meunier found, in a piece containing no visible troilite, iron 93.01, nickel 4.32, traces of sulphide and silica, and 0.7 per cent of insoluble residue. Besides a small quantity of white amorphous substance which appears to be silica, the insoluble residue consists of bright metallic and very magnetic needles of schreibersite. It contains also a black, earthy, amorphous matter which does not give reactions for sulphur or chromium, and is probably graphite. This constitutes 71.42 per cent of the residue, the phosphide being 28.58 per cent. The iron sulphide forming the cylindrical nodules above mentioned is of metallic luster and bronze-yellow color. A powder examined under the microscope shows indications of crystalline form. Treated with boiling hydrochloric acid the sulphide is dissolved with evolution of hydrogen sulphide. In the solution a large quantity of iron is present but no trace of nickel, but the solution is not complete; a black amorphous residue remains. This contains no sulphur. There occur also small grains of an uncolored, transparent substance like those observed in Caille. Examined under the microscope one sees fragmentary forms and brilliancy in polarized light. There are indications of crystal form, but on account of the small size nothing further can be determined. The amorphous matter gives no reaction for chromium nor phosphorous and appears to be formed exclusively of graphite like that contained in the iron itself. Others of the uncolored grains are remarkable for their fine striations. These are like what I have already noted in certain portions of the stony meteorites and in the fusion of eherzolites. In the latter they occur, not only in the olivine, where they are due to cleavage planes, but also in the enstatite, with its fibrous structure. It should be noted that these hard, hyaline grains, not decomposable by acids, found in the meteorites of Caille and Charcas are not found in the metallic mass but in the troilite nodules. The sulphide of iron thus presents a remarkable contrast to the iron in which it is disseminated. The meteoric iron has no appreciable quantity of sulphur and the sulphide has no nickel.

After noting all these physical and chemical qualities of Charcas it is superfluous to say that the mass could not be of terrestrial nor artificial origin. Its meteoric origin is as incontestable as is the memory of its fall preserved by tradition.

Meunier [5] made the following note on an oxidation product of the iron:

It presents a curious phenomenon with which the chemists do not seem to have concerned themselves. This consists of a very remarkable bright green effloresence, in striking contrast with the yellowish shade of the meteorite itself. This effloresence does not seem to be referable, to any considerable extent, to iron, but appears to be composed especially of chloride of nickel. It was kept in the air for over two years without changing color, which would not have been so in the case of a ferruginous chloride.

Some later study of the meteorite was made by Meunier [6] as follows:

It weighs 780 kg., and is about 1 m. in height, 47 cm. in length, and 37 cm. thick. The natural surface appears almost entire, but there is no crust like that of the iron of Braunau. This crust has, without doubt, been destroyed by oxidation. The general form of the mass is that of a truncated triangular pyramid, the edges of which are blunted. Upon its surface may be seen depressions such as have been mentioned. Some of these are very large, forming veritable basins, and upon their walls are a great number of small pits of various size. At one point also may be seen little depressions joining one another and resembling, in spite of the evident difference of origin, impressions made by drops of rain falling upon a soft substance. Some of the cylindrical cavities seem to be due to the disappearance of troilite, like those upon the iron of Charcas. A polished slab gives Widmanstätten figures of much neatness.

On page 21 of the same work Meunier gives an analysis of the graphite of Charcas. He found Carbon 98, Iron 0.9 = 98.9. Specific gravity, 1.309. On page 23 he states that the nickel-iron is naturally passive. On page 39 he gives a colored plate showing Widmanstätten figures brought out upon the iron by heating. These, he states, are of the character of long, fine, yellowish lines upon a ground of bluish color.

The specific gravity of the iron, p. 118, is given as 7.71 and its composition "after an approximate analysis made in the geological labratory of the museum" as follows:

Fe	Ni	Si	Sulphide	Insoluble residue	
93.01	4.32	trace	trace	0.70	=98.03

The insoluble residue, Meunier states, contains 25.584 per 100 of schreibersite and a large proportion of graphite.

Brezina [7] remarks regarding Charcas as follows:

Charcas, as well as La Caille, shows numerous tiny grains of troilite along the tænite and sometimes in the kamacite also. Laminæ 0.75 mm. wide.

Fletcher [8] gives a brief history of Charcas and thinks, on account of the similarity of figures with Catorce and the fact that a good wagon road runs from Charcas to Catorce, that they were a part of the same fall. This conclusion is not generally accepted, however.

Meunier,[9] in his revision, describes the structure further as follows:

This iron would serve as well as that of La Caille for the representative of its type. It differs distinctly, however, from the French iron and should not be confounded with it. The kamacite bands are of medium width. Plessite is much less abundant than in the Caille iron, the hatching is less conspicuous, and it shows small patches of pyrrhotine very much carburetted. These latter appear also in very peculiar line series in the interstices of the kamacite bands.

Brezina [10] in 1895 further remarks regarding Charcas as follows:

Charcas is distinguished from all other Mexican irons by reason of the very uniform distribution of troilite in dots all through the iron. According to Castillo it weighed 578 kgs. when it reached Paris. Fletcher identified it with Catorze and Descubridora, but I do not hold this proven on account of the constant occurrence of troilite and because of certain differences of structure. A recently acquired piece shows the already noted slight crumpling of the laminæ, kamacite slightly hatched, dotted with fine specks; the tænite strongly developed, fields very distinctly marked out and filled with finely flecked trias. Upon one cut surface occurs a troilite-bearing concretion of schreibersite about 1 cm. in size. Many cracks run parallel with the octahedral laminæ from the exterior toward the interior.

Cohen [10] found that the iron took on more or less strong permanent magnetism, although, as his result differed from that of Meunier and the piece was small, he thought that possibly he did not have a genuine piece of Charcas.

The meteorite is chiefly preserved in the Natural History Museum at Paris. The Ward-Coonley collection possesses 3,200 grams.

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Charles County. See Nanjemoy.

CHARLOTTE.

Dickson County, Tennessee.
Latitude 36° 12′ N., longitude 87° 22′ W.
Iron. Fine octahedrite (Of) of Brezina; Dicksonite (type 12) of Meunier.
Fell between 2 and 3 p. m., July 31 or August 1, 1835; described 1845.
Weight, 4–4.5 kgs. (9–10 lbs.).

This iron was first described by Troost[1] ten years after its fall as follows:

A member of the legislature of the State of Tennessee from Charlotte, county seat of Dickson (I do not remember his name), having seen my description of the Cocke County meteoric iron, mentioned to me some years ago that a curious mass of some metal was in the possession of one of his constituents, which he thought might be of the same nature as that of Cocke County. He was not able to give me any other information, but becoming acquainted since with the Hon. J. Voorhies, senator of Dickson County, I learned from him that such a mass really existed, that he knew the person in whose possession it was, etc. Having thus learned that I desired to obtain it my friend, the senator, did not rest till he had secured the specimen and put me in possession of it and its history.

I learned then the following facts from Senator Voorhies, and these facts have since been confirmed by other persons. In answer to a letter which I wrote about this iron to the senator, he answered: "I have collected all the facts in connection with the history of the meteoric mass which I sent you last year, but I have not been able to add much to those that I have already communicated. There is no doubt that this mass fell from heaven upon the earth, where it shortly after was found, though the precise date can not be recollected. I was told that a noise was heard in the air, which was preceded by a vivid light. This happened while several persons were laboring in their fields. A man who lives at present in this vicinity was plowing at the time when this took place; his horse took fright and ran around the field dragging the plow behind him; he recollected this circumstance very well, and it enables him to fix the date upon which the fall took place. He believes it was in 1835 on the last day of July or the first of August between 2 and 3 o'clock in the afternoon, the sky being cloudless. It fell before the last plowing in a cotton field opposite his dwelling. The iron was found when the field was plowed for the last time that season. Its fall was not vertical but much inclined and it traveled with great rapidity from west toward the east, as was evident from the furrow that had been made in the ground. The original shape of the mass was that of a kidney. Its smaller extremity was cut off by a blacksmith who yet lives in this vicinity. When it was first taken out of the ground it had the appearance as if it had been heated."

According to this letter and the information which I collected at the place itself where it fell—the Dickson iron fell, as already stated, on the last of July or the first of August, between 2 and 3 o'clock p. m. It has the form of a drop or rather of a depressed tear, one side is partly flat and partly concave, while the other side is convex—the form a drop of viscid matter would assume if it fell upon a hard floor. The surface has the appearance of smooth cast iron. It is surrounded by a zone or girdle of a metal of a whiter color and of a more compact texture possessing a more or less bright polish, which seems to have been produced by a more fluid part of the metal, squeezed through the pores of the already solid iron, by pressure probably occasioned by the fall, which, spreading itself as a thin cover over the surface, formed the zone or girdle mentioned above.

As mentioned above, the surface of the mass (when viewed with the naked eye) has the appearance of smooth cast iron; but the irregularity of this surface disappears when it is examined through a powerful magnifying glass. The whole becomes then a reticulated plane, formed by the edges of thin lamellæ of metal, separated from each other by an apparently semifused or slaggy matter. These lamellæ, running in an inclined position into the mass, intersect one another at angles of 60°, and consequently form equilateral triangles which divide the mass into regular octahedrons.

Its present weight is 7 pounds, 13 ounces. I presume the original weight, judging from the size of the piece cut off before it came in my possession, must have been between 9 and 10 pounds.

Its fracture, judging from the piece that was partly cut and partly broken off before I got it, has the character of that of a very soft kind of malleable iron, showing at the same time in its jagged fracture some regularity of crystallization.

Further studies of the meteorite are summed up by Cohen [9] as follows:

By Reichenbach,[2] Charlotte is often mentioned as an example in his description of the trias. He notes well-developed tænite, moderately dark plessite, fine combs, fine, regularly-developed figures with penetrating lamellæ, and delicate sheen like that of velvet. Further, he notes the small amount of accessory constitutents, the lack of glanzeisen, and the occurrence of bronze-colored troilite occasionally in little cylinders or cones. At one place he appears to include Charlotte among the irons with rust crust, since he, some pages further on, mentions that it has a smooth, delicate, black crust, like Hraschina. Smith [3] states that the mass was taken from between the roots of a great oak, and that the polished appearance of the surface remained after 40 years completely unchanged; also that sections showed no alteration when exposed to the vapors of the laboratory. The nickel iron was soft and ductile, free from schreibersite, and contained little cavities only to be noted under the lens. He observed no nodules of accessory constituents. From the appearance of the surface he concluded that no complete fusion could have taken place, except possibly on the edges and between the net-like ridges. The iron appeared to have been strongly heated but not melted because the heat was quickly conducted to the interior of the mass. Specific gravity, 7.717.

Analysis gave:

Fe	Ni	Co	Cu	P	S	
91.15	8.01	0.72	0.06	trace	0.00	=99.94

Wright [4] by heating filings obtained 2.2 volume of gas of the following composition:

H	CO	CO_2	N	
71.4	15.3	13.3	0.0?	=100.00

According to Meunier,[8] Charlotte consists only of plessite and tænite, thus making Dicksonite. It differs in structure from Jewellite.

Cohen's [9] own study of the meteorite is as follows:

Although among the long straight lamellæ about .17 mm. in breadth some lie isolated or only slightly grouped, yet in general a strong grouping into broad bundles seems especially characteristic of Charlotte. The kamacite is predominantly hatched, partly granular, the tænite evident. The octahedral structure shows considerable alteration, especially on strong magnification. The fields are strongly developed, making up about one-half of the section. In part they contain combs similar to the bands, and in part they contain plessite, which is either dull or shimmering. Troilite occurs in the form of Reichenbach lamellæ in the neighborhood of which a slight alteration in the structure can be noticed. Clefts filled with ironglass run parallel to the lamellæ. Finally, the very evident broad alteration zone 3.2 to 3.4 mm. thick should be noted. All these characters are shown in a piece in the Vienna collection, which from its form probably came from the thicker part of the meteorite. A plate from the Reichenbach collection appears considerably different. There is an externally strong bending of the lamellæ on one surface of the plate, which is 1.5 cm. thick, while on the parallel surface the bending is in part weak, but for the most part there is no deformation at all. Tænite is strongly developed and shows, where the bending is strong, a zigzag course. The bands are long and usually strongly grouped, quite free from granulation, and exceed in extent the fields. Most of the fields consist of granular kamacite like the bands and an etched surface resembles that of a granular ataxite if one holds the section so that the tænite is not reflected. Although the size of the grains appears under the lens quite uniform, under the microscope it is seen to vary between .02 and .08 mm. The great number of the very irregular but sharply-bounded grains furnish a similarly oriented sheen. Only a few fields consist of compact dark plessite or of such as is made up of grains of medium size. There are no accessory constituents. A piece in the Tübingen collection which is bounded on three sides of the natural surface and is about 25 mm. thick must have come from the pointed end of the pear-shaped mass. Probably, however, this whole mass has suffered alterations which, on the thicker part of the meteorite, were limited to the small outer zone. While an alteration zone is sharply defined, the octahedral structure is yet plainly discernible. The surface is in part covered with a black branching crust, as Reichenbach describes. It is so thin that one in most places can see lamellæ. Here and there the crust either fails completely or is limited to small spots which fill little depressions on the uneven surface. It does not give the impression that originally more crust was present here. Charlotte plainly possesses no uniform covering with crust, and this other writers have stated.

The meteorite is chiefly (2,359 grams) preserved in the Harvard University collection.

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Chattooga County. See Holland's Store.
Cherokee County, 1868. See Losttown.
Cherokee County, 1894. See Canton.
Cherokee Mills. See Canton.
Chester County. See Chesterville.

CHESTERVILLE.

Chester County, South Carolina.
Latitude 34° 43′ N., longitude 81° 13′ W.
Iron. Nickel-poor ataxite of Brezina; Braunite (type 3, sec. 2) of Meunier.
Found a few years prior to 1849; described 1849.
Weight, about 16 kgs. (35 lbs.), of which half was forged.

The history and characters of this meteorite have been summarized by Cohen [13] as follows:

Shepard [1] states regarding this meteorite that he was informed through a letter from Dr. E. H. Andrews that the iron was found by plowing on the Columbia Road 6.5 miles below Chesterville, Chester County, South Carolina. About half of the original block, which weighed 16½ kg. and whose form was comparable to that of a Unio shell, was worked up into horseshoes, nails, and door hinges.

The outer surface was very much notched and covered with rust. By a preliminary chemical examination Shepard found traces of cobalt and chromium, besides a content of nickel of about 5 per cent. Iron sulphide present in lumps yielded in solution fine scales of graphite. Etching produced on one place scattered figures which resembled Chinese characters, on another, short, straight lines with quadrangular cross section, which occasionally arranged themselves in meshes like a cobweb; in the spaces between the raised glistening linear systems small shiny points were sometimes observed, sometimes also fine Widmannstätten figures.

Clark [3] determined the specific gravity as 7.818; Wöhler [2] found the iron active.

Reichenbach [4] first referred Chesterville to his group of iron meteorites of the simplest composition, which consist entirely of kamacite and are rich in glanzeisen in irregular lumps scattered throughout the mass without any order. Later he undoubtedly reckoned Chesterville among the irons with trias which are free from combs. He mentions bronze-colored iron sulphide in roundish lumps of moderate size and gives the specific gravity as 7.55.

Rose [5] described Chesterville as a fine-grained mass, which yields a dull etching surface with small roundish eminences, and, lying between these, shiny grains of various forms. He also notes a steel-gray and fine-grained fracture, and a black, thin, and uneven crust.

According to Meunier,[6, 8] this meteorite consists solely of Braunine ($Fe_{16}Ni$) with deposits of schreibersite, rhabdite, iron sulphide, and black substances.

Brezina [7, 9] first noted that the rhabdite was arranged according to definite crystallographic planes throughout the entire mass of the iron and classified it under the hexahedral irons, since he regarded as probable an orientation of the rhabdite according to the hexahedron.

Cohen [12] continues as follows:

On weak etching there appear, on the homogeneous groundmass, little rounded elevations 0.03 mm. broad and double to six times this length, in large numbers and lying close together, so that the surface presents a swollen appearance, like that of Campo del Cielo and Cincinnati, although in Chesterville it is considerably less prominent and is only plainly visible under a strong lens. On stronger etching the previously homogeneous groundmass exhibits numerous isometric grains 0.05 to 0.2 mm. in diameter, irregularly bounded, and with a delicate, oriented sheen. Its granular structure is most plainly marked in the neighborhood of the large rhabdites or schreibersites, since here the swellings fail, so that they are surrounded by a dull etching zone. Here and there originate, after strong etching, little striated pits which seem to run parallel to one another and to be oriented perpendicularly. Chesterville is distinguished by a considerable content of nickel-iron phosphide. In part, this appears in the form of sharply bounded rhabdites, which are now long and thin, now short and relatively thick. Thus, a needle 4 mm. long is only 0.05 mm. thick, while most which are only half as long have four times the above thickness. In the larger many are broken and the pieces are dislocated. One can, however, often recognize their connection by the shape of the fractured surfaces. The formation of the rhabdites must have been finished before the surrounding nickel-iron reached a cooled condition,

since there is no indication of an opening produced by the dislocation. Only on some sections are the needles oriented according to two perpendicular directions. Another part of the nickel-iron phosphide is quite irregularly bounded, and the lumpy-shaped individuals are united to hieroglyphic groups. Besides the nodules mentioned by Shepard and Reichenbach of measurable compass and, as it seems, of rare distribution, there occur also little troilite particles surrounded by a small zone of schreibersite. Leick has tested Chesterville according to the methods employed by him in his work on the Magnetic Relations of Galvanic Iron, Nickel, and Cobalt Precipitates. It exhibited the properties both of steel and cast iron. Like the former, it took on permanent magnetism which by strong jarring was little weakened. On the other hand, in the magnetic spiral it behaved like cast iron, although the temporary magnetism was only one-fifth to one-fourth as strong as in the latter. Qualitatively, it showed the same properties as the electrolytically precipitated nickel-iron alloys. The specific magnetism was determined as 0.14 absolute units per gram; the polar magnetism was not determinable.

Analyses by Sjöström [10, 11]:

Fe	Ni	Co	Cu	Cr	C	P	S	
93.15	5.82	0.73	....	....	....	0.34	....	=100.04
93.80	5.50	.75	0.02	Trace.	0.02	.34	0.03	=100.46
94.25	5.03	.68	.02	Trace.	.02	....	....	=100.00

Mineralogical composition:

Nickel iron	97.72
Schreibersite	2.20
Iron sulphide	.08
	100.00

Specific gravity (Leick) 7.8209 to 7.8737.

Relative to the arrangement of rhabdite and chemical composition single portions of the meteorite seem to behave differently. The swollen appearance of etched faces makes Chesterville resemble the Siratik group, but it differs from the latter by the lack of the characteristic depressions, and in the arrangement of the rhabdites, on which Brezina lays great weight, Chesterville resembles the hexahedrites. Although it may be true, as seems here and there to be evident, that these are arranged according to the faces of the cube, this need not be decisive for the classification any more than the hexahedral orientation of the Reichenbach lamellæ in the octahedrites. If one should consider the latter as deciding the structure of the main mass of the nickel-iron, then they must apply this rule to all irons which consist of grains without octahedral structure and without Neumann lines.

The meteorite is distributed. London possesses 2,250 grams, New Haven 758, and Vienna 681.

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CHILKOOT.

Chilkoot Inlet, Portage Bay, Alaska.
Here also Chilkat.
Latitude 59° 20′ N., longitude 136° W.
Iron. Medium octahedrite (Om) of Brezina.
Mentioned 1881.
Weight, 43 kgs. (94 lbs.).

This iron, according to the account of the State Mining Bureau,[1] was obtained from the locality above indicated in June, 1881, by the State Mining Bureau of California. It was purchased, it is stated, from Chief "Donawack" or "Silver Eye," who said that it had been seen to

fall by the father of one of the oldest Indians about one hundred years before. It is also stated that Widmannstätten figures can be dimly seen on the outer surface of the mass and can be brought out beautifully by acids. Most of the mass is still in the possession of the Mining Bureau.

Ward [2] states that an etched face in his possession shows typical and prominent Widmannstätten figures with an unusual abundance of tænite bands. The label of the meteorite, as it is exhibited in the State Mining Bureau, gives the following analysis:

Fe	Ni	Co	P	S	Cu	C	Loss	
92.56	7.11	0.12	0.12	0.04	trace	trace	0.05	=100.00

The exterior of the iron is bright nickel-white in color, indicating a rather recent fall. Its shape is that of a low cone, indicating orientation, and it is deeply pitted. Specific gravity, 7.76.

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CHULAFINEE.

Cleburne County, Alabama.
Latitude 30° 30′ N., longitude 85° 35′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found, 1873; described, 1880.
Weight, 16.2 kgs. (35.75 lbs.).

This meteorite is thus described by Hidden: [1]

Some time in 1873, while the Rev. John F. Watson was plowing on a newly cleared piece of land near Chulafinee, Cleburne County, Alabama, he turned up a heavy mass of metal. He supposed it to be a rich specimen of bog-iron ore, which exists in considerable quantity in that vicinity, and took the mass home. It was originally thickly encrusted with scales of rust of a red-brown color, which fell off on heating in a blacksmith's forge to test the nature of the mass. The blacksmith removed 3.25 pounds, which he worked into horseshoe nails and a plow point.

The mass was somewhat triangular in shape and measured 25 cm. in diameter by 6 cm. in thickness. Its weight was 32.5 pounds (14.75 kg.), exclusive of the 3.25 pounds above mentioned.

Analysis of the iron by J. B. Mackintosh [2] gave:

Fe	Ni	Co	P and O	
91.608	7.368	0.500	1.70	=99.646

The mass came into the possession of the Vienna Museum and Brezina [3] observed as follows regarding it:

There were many large open cracks on the outside of the iron which penetrated deeply into the interior. In many places scattered over the entire surface the original fusion-crust was still distinctly visible and conspicuous on account of its peculiar reddish-brown color and sharp distinction from the iron mass. In two places the fusion crust showed especially beautiful lines of flow which, running away toward the edge of the mass, indicated the direction of the flight of the meteor. On etching, the iron was attacked with difficulty and the kamacite showed at the beginning of the process no etching figures, but only a confused mottled glimmering. Only by long continued etching did the figures appear distinctly. Upon a large face having symmetrical figures there appeared a very small portion, embracing only a few short laminæ of a readily soluble iron, which just at first showed beautiful etching lines and afterwards was of similar aspect to the main portion of the mass.

Upon etching it is also shown that the numerous cracks run parallel to octahedral laminæ, having on the whole a crooked course. They are composed of octahedral cleavages arranged *en échelon*. An inclusion of magnetite found upon this cleft gave the impression that this was formed in a late stage of the flight if not actually upon the earth. The iron is rich in small inclusions of graphite with which troilite is associated sparingly and subordinately.

Later the same author [4] noted numerous troilite points distributed through the whole mass. Larger troilite nodules are at times intermingled with the graphite. Troilite particles are also described bordered with tænite, giving the former the appearance of being inclosed in brackets. The banded structure of the kamacite is noted as in many places changing to granular. The width of the laminæ is given as 0.6 mm.

This iron is chiefly preserved in the Vienna Museum.

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CHUPADEROS.

Rancho de Chupaderos, 18 miles from Jimenez, Chihuahua, Mexico.
Latitude 27° N., longitude 105° 4′ W.
Iron. Fine octahedrite (Of) of Brezina; Caillite (type 18) of Meunier.
Known for centuries; mentioned 1852.
Weight, two large masses weighing 14,114 and 6,767 kgs. (31,050 and 14,885 lbs.).

The history and characters of these great masses have been summed up by Cohen [14] as follows:

In the view of Fletcher [7] certain remarks of Bartlett [1] in the description of his journeys relate to the shell-like masses of Chupaderos. The latter states that in 1852 he received word that there were in the neighborhood of Huejuquilla (Jiminez) some large masses of meteoric iron, and though an expedition sent out by him was unsuccessful in finding them, he did not doubt the presence of such masses. Fletcher also thinks that the short mention by Smith [2] of newly discovered huge iron masses in Mexico relates to these. Urquidi, who owned the Hacienda Concepcion, was of the opinion that the masses of Adargas, Morito, and Chupaderos originally formed one meteor which burst at a great height. Barcena [4] mentions masses at the Hacienda Concepcion approximating in form, as do most Mexican meteorites, to that of a prism with arched faces. Rammelsberg [5] determined in 1879 the content of nickel and cobalt in the Chupaderos meteorite, receiving his material, as Fletcher thinks, from Burkhart. The first detailed information was furnished by Castillo.[8] He states that the place of find is the Rancho de Chupaderos, 18 miles from the railroad station of Jiminez, earlier called Huejuquilla. Both masses were of the shape of a flat parallelopipedon and rich in cylindrical hollows in part filled with troilite. The specific gravity of the iron was 7.18. The smaller mass weighing 9.290 kg. measured 2.15 by 1.10 by 0.50 m.; the larger weighing 15,600 kg. measured 2.50 by 2 by 0.40 m. The surface of fracture showed that the two masses belonged together. They lay only 250 m. apart. Castillo shares the opinion of Urquida that the masses belong with that of Adargas and Morito, and that at a great height a separation took place into three parts, one of which, nearer the earth's surface, again divided. According to the history of Philip II the masses were discovered in 1581 by Antonio d' Espejo. Fletcher thinks, however, that this is a mistake. Fletcher also believes that the two masses belong together. This, he thinks, on account of the similarity of the surfaces, all of which are, for example, very rich in troilite, and on account of the rarity of meteorites of this size. It could scarcely be believed, he thinks, that in so narrow a space such large masses could have fallen at three different times. The present separation, of 65 miles he did not deem significant, since Morito and Adargas had been transported some distance. Meunier [11] assigns Chupaderos to his Caillite group. He states that the kamacite strongly predominates and the tænite exists where two bands are thrown together. He mentions also that little schreibersite is present and that there is a lack of troilite, although the piece studied was of considerable size. According to Brezina [12] the two masses, whose structure completely agrees, belong together. He describes the lamellæ as long, straight, moderately grouped, slightly swollen; the kamacite has a fine oriented sheen, as if from very delicate lines, which, however, can not be seen microscopically. The tænite is well developed, the fields abundant, about equal in quantity with the lamellæ; plessite with or without combs or points. Large lamellæ of schreibersite occur inclosed in swathing kamacite 2 mm. thick and very large troilite cylinders which, near the surface, are usually quite or in part empty. On account of essential differences of structure Brezina thinks that Adargas and Morito can not be united with Chupaderos. In a piece which I have at hand the lamellæ are long, in part straight, in part somewhat sinuously bounded; at times somewhat granular, only here and there moderately grouped; the tænite very strongly developed; the fields abundant and not less in quantity than the lamellæ. The kamacite consists predominantly of quite irregular but sharply bounded grains, a great number of which have the same oriented sheen. Although of varying dimensions, the diameter occasionally reaches 0.25 mm. Here and there the kamacite is flattened by point-like depressions. In such places under the microscope systems of lines can be recognized which I regard as ridges but which are considerably less in number and less visible than the typical hatched kamacite. The small fields are composed of compact dark plessite, usually fine-grained and gray, but darker than the kamacite. Both kinds consist of a compact appearing groundmass and numerous uniformly distributed shining flakes. In the lighter fields the latter are larger and form in part rounded spots 0.03 mm. large and in part extraordinarily fine threads. The edge of such fields is often more fine grained and darker than the central part. Occasionally small complete lamellæ cross a larger field, or the latter is composed almost wholly of them. Finally fields occur very sparingly in which the tænite is distributed in the form of combs. In these cases the kamacite is like that of the large bands but somewhat finer grained. Schreibersite is quite abundant but irregularly distributed, partly lying in the bands, partly appearing in large individual crystals, and often surrounded by granular swathing kamacite. The iron is attacked with difficulty by dilute hydrochloric acid. For solution it is necessary to make the

acid twice as concentrated as usual. The residue furnishes felted, tinder-like, aggregates that obviously consist of plessite which was composed of small complete lamellæ in which the tænite bundles protected the kamacite nucleus from action by the acid.

Rammelsberg's [8] analysis showed Ni 5.12; Co 0.82.

Analysis by Cohen and Weinschenk [9] gave:

Fe	Ni	Co	P	residue	
90.23	8.76	1.21	trace	trace	=100.20

Analysis of tænite from the meteorite by Manteuffel [10] gave:

Fe	Ni	Co	
65.39	33.20	1.41	=100.00

The specific magnetism was determined by Leick as 0.31 absolute units per gram.

Farrington [15] has the following note in regard to the masses:

The two known masses of this meteorite were found, as was stated at an early period, lying only about 800 feet apart. This proximity and the jagged surface to be found on each renders it very probable, as was suggested by Daubrée, if not earlier by others, that the two pieces once constituted a single mass which was torn apart during its fall to the earth. The probable dimensions of this mass were given by Daubrée as follows: Length 4.65 m. (16 feet), width 1.50 m. (5 feet) and thickness 0.45 m. (22 inches). The dimensions thus obtained by Daubrée were evidently arrived at by assuming a joining of the two masses end to end. Such a joining, however, would not place the torn surfaces together. In order to determine what the form and dimensions of the mass would have been if the two parts were joined along the fractured surfaces, the two full-sized models of these masses in possession of the Museum were joined in this way. The resulting form is shown in a plate. It is seen to be broad and tabular with irregular outline. Along the line where disruption took place there was an evident constriction. The correspondence between the broken surfaces is such as to leave little doubt that they were once joined. The dimensions of the mass so formed are: Length 12 feet (3.6 m.) and width 7 feet (2.1 m.). The weight of this mass would have totaled about 21 tons (20,881 kg.). It would be of interest to know which surfaces of the two masses lay uppermost when found, but no record seems to have been made of this point. There is a marked difference in the pittings on the two broad surfaces and they correspond on the two masses when joined. Thus pittings on one side are deeper and narrower than those on the opposite side. The indications are therefore that the side first mentioned was the front side in falling.

As the writer is not aware that any photographs of the two original masses have ever been published, cuts from photographs made by him in 1896 are presented. These show the masses as they are installed in the National School of Mines in the City of Mexico.

In addition to the data cited by Cohen it is stated in the Bosquejo Geologico de Mexico [13] that the two masses lay at the foot of the eastern slope of the Sierra de Chupaderos at a distance of 250 m. from each other in a north and south direction.

The masses were removed in 1891 by the Mexican Government to the School of Mines of the City of Mexico and are still there. The weights of the masses given at the heading of this account are taken from the labels at the School of Mines. These weights differ slightly from those given by Castillo [8] but are probably correct.

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CINCINNATI.

Old collection in Cincinnati, Ohio.
Latitude 39° 7′ N., longitude 84° 29′ W.
Iron. Ataxite, Siratik Group (Ds) of Brezina.
Found 1898; described 1898.
Weight: Only 28 grams known.

The first mention of this meteorite occurs in Wülfing's catalogue [1] where he states that the following was communicated to him by Weinschenk:

The Cincinnati iron was presented to the Munich Institute by Hosaeus, who possessed a section of considerable size and was in doubt as to its meteoric character. The iron had a tolerably high percentage of nickel, was quite thick, and showed small shiny rods; its meteoric character seems doubtful to me. It is said to have been found near a dwelling house in Cincinnati, Ohio.

Dr. Weinschenk later placed at the disposal of Professor Cohen, for investigation, a piece weighing 28 grams and having a section surface of 6.5 sq. cm. Cohen [2] describes this as follows:

The iron behaved, upon etching, quite like that of Campo del Cielo and Siratik. After exposure for a short time to the action of nitric acid a few small glistening grains appear, while the groundmass remains shiny and even. Under the microscope one can discern very fine furrows which seem to consist of grains 0.02 to 0.2 mm. in size, which reflect the light simultaneously. By stronger etching the grains increase and depressions resembling indentations appear; the number of both is distinctly small, however. Moreover the iron does not behave the same over the entire section surface. About two-thirds of the surface takes on a puffy-rough character like that of Campo del Cielo, with a distinctly parallel arrangement of the puffy eminences; on the other portion, which does not show so many large grains or indentations, a distinctly granular structure appears, like that which Siratik shows, with about the same degree of etching. The individuals, sharply separated from one another, are isometric in the larger specimens, but in the smaller they are variously bent and indented; the larger number at all events reflect the light simultaneously.

The nature of the large grains and the depressions resembling incisions formed by stronger etching can not be determined with certainty here any more than in the case of the other two mentioned meteoric irons. I think it probable, however, that the grains are formed by lamellæ of troilite covered with a thin pellicle of nickel-iron which protects the lamellæ of troilite against the action of the acid for a time; when this thin coating of nickel-iron is eaten away, however, then the lamellæ of troilite are dissolved out and leave depressions of the form of the lamellæ.

Of accessory constituents only a few irregularly formed particles of schreibersite were observed in one place.

Analysis (Sjöström):

Fe	Ni	Co	Cu	P	S	
94.47	5.43	0.68	0.01	0.05	0.05	=100.69

Specific gravity (Leick) 7.6895. The specific magnetism per gram as determined by Leick was 0.44. Permanent magnetism weak.

Since the Cincinnati meteorite does not correspond exactly with either that of Campo del Cielo or Siratik there appears to be no occasion for supposing a confusion on the part of Hosaeus to which view one might readily enough be inclined by a cursory examination of the Cincinnati iron. On the other hand, since I had but one piece of each of the three meteorites at hand for comparison, other portions of the Campo del Cielo and Siratik irons may after all show similar structural differences to those of Cincinnati.

If Cincinnati be regarded as an independent fall, then it forms, with Siratik and Campo del Cielo, a well-defined group of ataxites poor in nickel, which is distinguished by puffy grains and depressions resembling incisions, and whose representatives possess nearly the same chemical composition.

Only a small quantity of the iron is known. Minod in Genf is said to possess a large piece. Munich has 28 grams.

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Claiborne. See Limestone Creek.

Claiborne, 1853. See Tazewell.

Clarke County. See Limestone Creek.

Claywater. See Vernon County.

Cleburne County. See Chulafinee.

CLEVELAND.

Bradley County, Tennessee.
Here also Bradley County, East Tennessee and the Lea Iron.
Latitude 35° 8′ N., longitude 84° 53′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1860; described 1886.
Weight, 115 kgs. (254 lbs.).

A notice by Shepard[1] in 1866 has usually been regarded as referring to this meteorite, but this is not certain. Shepard simply says that he had been informed of an iron meteorite discovered by a mining explorer on a mountain in east Tennessee and described as being "as large as a man can lift." The finder hammered off only a very small fragment, which was forwarded to Shepard, by letter, for examination. Its original structure had been destroyed by the process of detaching it from the mass. It was nevertheless highly malleable, with the usual luster and color of meteoric iron.

The only detailed description of the mass,[2] also known as the Lea iron or East Tennessee meteorite, was given by Genth[3] as follows:

The history of this meteoric iron is very meager. In August, 1867, Dr. Isaac Lea sent a specimen of some 5 grams weight to me for examination. The analysis not known, finished August 11, 1867, proving it to be a meteoric iron, induced Dr. Lea to purchase the specimen.

May 11, 1868, Julius E. Raht, of Cleveland, Tennessee, wrote me:

"I send you to-day a small piece (44 grams) of meteoric iron which was broken off from a mass weighing 50 pounds which fell about 8 years ago near the State line of Georgia, 10 miles from Cleveland, Tennessee. The piece has been sold into Mississippi."

In the fall of 1868 J. Lawrence Smith wrote to congratulate Dr. Lea on the acquisition of the Mississippi meteorite, regretting at the same time that absence in Europe prevented his securing it for his own cabinet.

It now remained in the possession of Dr. Lea until he presented it to the Academy of Natural Sciences of Philadelphia. The museum record simply notes the date of its reception, October 24, 1876; that it came from the mountains of east Tennessee, and that it weighed 254 pounds. All efforts to obtain fuller information as to its fall and discovery proved unsuccessful.

The discrepancy in the figures as to the weight of the mass must be charged to incorrect information received by Mr. Raht. Smith's letter to him, however, identifies the "Mississippi meteorite" with the one Mr. Raht stated to have been sold into that State.

The mass shows on one corner the place where the 44 grams were broken off by Mr. Raht for examination. It is an irregularly shaped, somewhat triangular mass of about 45 by 40 by 22 cm. in size. Its crust is very thin, with only here and there a spot of rust. It shows one fracture 10 mm. in greatest width by 15 cm. in length. The pitted appearance of the mass shows beautifully in a photograph. Its original weight was nearly 115.5 kg.; probably 2.5 kg. have been cut off and distributed as specimens.

The crystalline structure is beautifully shown on the etched surface of the polished sections, indicating very clearly the octahedral form. The Raht specimen gave exactly the same etching figures, proving the identity of the meteorite.

The usual constituents of this class of meteorites are quite perceptible in this one, the kamacite largely predominating and forming bands 1 to 3 mm. in width. The tænite, enveloping the kamacite, frequently subdivides the broader bands of the latter into narrow lines. The length of the kamacite individuals is from 1.5 to 2 cm. It has a dull gray color and when magnified can be seen to be intersected in every direction by very fine lines, probably of schreibersite. The plessite, somewhat darker than the kamacite, mostly shows a very fine crystalline mottled structure (*moire metallique*) and a glittering luster; a small portion, however, is quite dull and much darker.

On one specimen there is in two places a remarkable admixture of an iron which is a great deal smoother and hardly shows any crystalline structure. This iron is brighter than any other portion of the etched surface and has a slightly yellowish hue. The patches are not perfectly smooth, however, but show many very minute depressions. In the center, where this iron is narrowest, and on some portions of the unetched surface small spots of rust have made their appearance. An examination proves the presence of a considerable quantity of chlorine, from which it is evident that these are the result of the oxidation of ferrous chloride which this meteorite contains in small quantities.

The so-called "alteration zone" next to the surface is quite distinct and is 1 to 1.5 mm. in width.

Genth's analyses are as follows:

	Fe	Ni	Co	Cu	P	S	
(1)	88.92	9.82	0.77	0.23	0.19	undt.	=99.93
(2)	89.94	8.507	0.69	0.08	0.109	0.006	=99.332
(3)	89.93	8.06	0.56	0.06	0.66	undt.	=99.27

Meunier [4] described the structure of the iron as follows:

The kamacite is in bands, very rich in Neumann lines, and limited by the very thin leaves of tænite. The plessite is normally abundant and in some places black inclusions of several millimeters diameter are visible. Dissolving in acid produces a little hydrogen sulphide and liberates the scanty laminæ of schreibersite.

Cohen [5] remarked that Reichenbach lamellæ were very numerous and beautiful in this meteorite.

Kunz [3] suggested that Cleveland was of the same fall as Dalton, q. v.

The iron is chiefly preserved in the Museum of the Academy of Sciences of Philadelphia.

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COAHUILA.

State of Coahuila, Mexico.
Latitude 28° 42′ N., longitude 102° 51′ W. (Fletcher).
Iron. Hexahedrite (H); Coahuilite, type 4 of Meunier.
Known since 1837; described 1855.
Weight many thousands of pounds. The Butcher irons consist of 8 masses weighing 654, 580, 550, 438, 430, 404, 353, and 290 pounds; total, 3,699 pounds (1,678 kg.).

The history of this puzzling group of meteorites has been given by Cohen,[53] as follows:

From the Mexican States, Nuevo Leon and Coahuila, and especially from the territory known as the Desert of Mapimi, lying partly in Coahuila and partly in Chihuahua, as well as from the neighboring portion of Texas, numerous hexahedrites have been, under different names, in part carefully described and in part briefly mentioned. With the question whether all these hexahedrites belong to one fall or many, Smith, Burkart, Huntington, Fletcher, and Brezina have occupied themselves. Smith,[14] in 1871, was of the opinion that all the irons found on the Desert of Mapimi, within a radius of 500 miles, belonged to one great fall. He included among these not only the hexahedrites of Saltillo and the Butcher irons but also the octahedrites Morito and Adargas. Burkart [11] considered it probable that Saltillo, Bonanza, and the Butcher irons might belong to one fall which took place in 1837 in the region of Santa Rosa, but left the question open. Huntington,[32] in 1887, came to the conclusion that the Coahuila irons of the Sanchez Estate and Fort Duncan could not be separate, since their specific gravity, composition, etching figures, and other properties showed no differences, but he included the octahedrites of Morito and Adargas in the Coahuila iron. Two years later he [35] changed his view, since he observed in the Butcher irons cleavage different from that of Sanchez Estate and Fort Duncan, while that of the latter corresponded with that of Scottsville and Holland's Store, and regarded this as proof that two different falls occurred; the one furnishing the Butcher iron, the other the remaining four irons. From this he came to the conclusion that one meteor which passed over the North American continent let fall masses at widely separated points. These views have not been shared by other investigators. Fletcher's investigations [38] were of special importance since he collected all the literature and studied it critically. He concluded that before the introduction of railways transportation of heavy masses from the coast to the interior was difficult and expensive, and hence a distribution of iron masses for use as anvils could have taken place. Such distribution had often been proved and hence seemed probable even where no direct proof existed; also the belief that such masses might contain precious metals would also often cause their distribution. Fletcher describes the way in which different masses might have been transported. Since all the irons were hexahedrites he hardly thought it possible that two falls of the same type could have occurred in a relatively limited area. His conclusion was that all the above-mentioned irons belonged to one fall and the fall took place in a limited area. Later, Fletcher modified his view in so far as Fort Duncan was concerned, since in the catalogue of the London collection he gives this iron a separate locality with the remark that it may have come from the same region as the Coahuila iron. Brezina [47] thought, on the other hand, that two separate falls took place, since some of the irons are distinguished by a high content of rhabdite and (probably on account of this) are attacked with difficulty by acids. One locality he designates as Fort Duncan and includes with it Sanchez Estate and the so-called Smithsonian iron. To the other locality, Coahuila, he ascribed all the other irons. For the present, I follow Brezina's conclusions, although his arguments are no more convincing than those of Fletcher. On the one hand the fall of two masses of hexahedrites at no great distance from one another is not very probable but not impossible; on the other hand we know little regarding the relations of the single masses of an iron shower. The greatest number of different masses in such a case have been investigated in Toluca, and these are all octahedrites of medium width though all show some differences in their intimate structure; of Canyon Diablo some pieces are rich in cohenite, some almost free; of Babb's Mill, there are two masses which seem to belong together through similarity of structure, but their chemical composition is very different.

A list of the irons at different times included among the Coahuila hexahedrites is given by Cohen,[53] as follows:

1. Sanchez Estate, Santa Rosa, Coahuila (Saltillo: Couch-Iron); 1850. Here belongs also Genth's New Mexico; 1854.
2. Cerralvo, Nuevo Leon; 1856.
3. Hacienda Santa Rosa, Coahuila; 1863.
4. Bonanza, northwest of Santa Rosa, Coahuila; 1866.
5. Butcher's Iron, Coahuila (also known as Bolson de Mapimi (Mapini); 1866.
6. Hacienda Potosi, District Galeana, Nuevo Leon; 1870.
7. Smithsonian Iron ("unknown locality") of many English catalogues; 1881.
8. Fort Duncan, Maverick County, Texas; 1882.
9. Santa Rosa, Coahuila (Lupton's Iron); 1885.
10. Santa Rosa de Muzquiz, Coahuila; 1889.

Of the above, those of Cerralvo and Hacienda Potosi seem to be lost and may be disregarded. Cohen [53] gives a further history of the group, as follows:

Santa Rosa de Muzquiz, Hacienda St. Rosa, Santa Rosa (Lupton's Iron).—According to Castillo,[26] Santa Rosa de Muzquiz is a roundish, nonoxidized block; the iron shows Widmannstätten figures. From the latter statement it does not follow that this is not a hexahedrite, since by many authors Neumann lines are regarded as Widmannstätten figures.

Under the name of Hacienda St. Rosa Wichelhaus [5] described a meteoric iron obtained by Posselt from the Heidelberg collection. It was of an entirely homogeneous appearance; the absence of Widmannstätten figures was, as in so many cases at that time, referred to the scarcity of schreibersite. The analysis follows (I, p. 131). Rose [6] adds that the iron constitutes an individual, cleaves in entire conformity with the cube, gives Neumann lines, contains numerous rhabdites lying parallel to the angles of the hexahedron, and corresponds exactly with Braunau and Claiborne (Walker County). Rose, however, makes a wrong use of the data from Burkart; since these refer to Saltillo, Rose supposed that the latter iron was identical with Hacienda St. Rosa. According to Posselt, in the region in question, "Iron of meteoric origin lies scattered around in large blocks, or extended over a long stretch by rolling."

Lupton [26] saw, in front of a house in the neighborhood of Santa Rosa, a block of irregular form, estimated at 97 kgs. weight, which was said to have come from the same region as the masses collected by Butcher. The iron gave no Widmannstätten figures and its characteristics corresponded with the description by Smith. The analysis follows (II, p. 131).

Fletcher [38] regarded St. Rosa, Santa Rosa de Muzquiz, and Santa Rosa as one and the same locality, which he designated upon his labels as Santa Rosa de Muzquiz. Likewise it is scarcely to be doubted that all the masses observed in the city and its neighborhood were transported thither from the same region not far distant.

Bonanza.—According to Shepherd,[7] fourteen massive blocks of iron lay in a locality 160 miles northwest from Santa Rosa, the largest of which had the form of a beehive with a diameter of 1.5 m., projecting more than a meter above ground, and still considerably embedded therein. His companion, Hamilton, estimated the distance from Santa Rosa as considerably less and mentioned only thirteen more or less rounded masses free from rust, which lay as far as 1 mile from one another. According to this author a block weighing 34 kgs. was brought to Santa Rosa; of the rest the smaller ones weighed from 900 to 1,400 kgs. Shepard [7] selected for the iron, of which he possessed a piece, in accordance with the label from Shepherd, the name Bonanza, and thought that it was different from the Sancha Estate iron. He noted several shallow pittings on the natural surface, no fusion crust, distinct cleavage, etching lines, some rhabdite, and emphasized the structural identity with Braunau. The analysis of the iron follows (III, p. 131).

It is concerning the same locality, no doubt, that Veatch and Schott reported, although the distance from Santa Rosa is given differently. In 1849 Veatch [8] saw a large mass of iron, used as an anvil in Santa Rosa, and he learned of numerous pieces of the same sort which had been used for various purposes, and which had come from the mountains northwest of the city. Schott [4] learned from Long that 90 miles northwest from Santa Rosa numerous masses of iron were to be found up to the size of a cubic meter; from one weighing about 11 kgs. had been hammered out, without heating, several small objects.

Butcher iron.—In 1868 Butcher [12] brought to the United States from a locality 90 miles northwest from Santa Rosa eight blocks weighing respectively 131½, 160, 183¼, 195, 198¾ 249½, 263, and 296¾ kgs., or a total of 1,678 kgs. He estimated the original masses considerably higher in weight, since on the one hand it was with difficulty that all the blocks were found, and on the other hand a few of the blocks had been brought to Santa Rosa at an earlier date, in the belief that they were silver. According to a communication from Long, Butcher was inclined to refer the iron masses to a meteor which was observed at Santa Rosa in 1837 and which had moved in a northwesterly direction. At all events as early as 1837 an Indian had brought a piece of the iron to the city.

According to Smith,[10] the blocks are of irregular form, compact, entirely free from silicates, and composed of soft, easily cut iron. The analysis follows (IV, p. 131). Smith supposed that the iron known under the name of Santa Rosa came from the same locality; Burkart [11] considered that Saltillo was to be included here also.

Later, Smith [16], [17] made the Butcher iron the subject of further investigation. In 1876, he described an incrustation of aragonite upon two blocks, and a new mineral, which occurred mixed with troilite, both surrounding and penetrating it. He considered it a ferric compound of chromium and sulphur (CrS) and proposed the name daubréelite for it. When two years later he found, upon a section surface measuring 1,800 sq. cm., about 30 troilite nodules of $\frac{5}{16}$ mm. in diameter, all of which were penetrated by the mineral in question, he succeeded in securing pure material in considerable quantity. He obtained this time the percentages from which the formula, FeS. Cr_2S_3 was derived. In 1881, he [18] found an oval lump of chrome iron 17 by 12 mm. in size, with 62.71 per cent Cr_2O_3, 33.83 per cent FeO, traces of Co, and a few included silicate grains. This was the only large chromite nodule hitherto observed in meteoric iron.

Daubree [19] observed as many as 70 inclusions of troilite with daubréelite, sometimes roundish in form, sometimes angular, upon a section 800 sq. cm. in size, as well as a cleft extending entirely through the same and filled with magnetite.

Brezina [22] made a series of further investigations. He found in a druse of the otherwise compact iron a crystal of troilite 12 mm. high and of the same thickness, showing the faces 2P(2021) and OP(0001) with distinct basal cleavage; the faces of the pyramid were many faceted and scratched near the base. Brezina thereupon came to the conclusion that iron sulphide in the stone and iron meteorites was apparently as little chemically as crystallographically differentiated, and that it was in both cases pure iron sulphide. Four plates of daubréelite of 0.2 to 6 mm. in thickness were inserted in the troilite crystal parallel to the base, and it is supposed that in the remaining noncrystalline troilite there is the same regular orientation of the daubréelite. He further noted the occurrence of the troilite in the form of Reichenbach lamellæ, which attained a length of 10 cm. and was always surrounded by a granular zone 1 to 1.5 mm. wide. Also where short, straight little troilites accumulate the whole mass is surrounded by an area in which etching lines are almost entirely wanting. In the same year Brezina described a peculiarly wrinkled parting face extending through the entire block along which, upon cutting, a division appeared. In 1885 he [25] united the Butcher iron and Santa Rosa with Saltillo; in 1895 he [47] separated the latter and placed it with Fort Duncan. Finally he mentioned a piece the size of a fist consisting of a hollow body with included nodules which showed outer crust and pittings meeting in a sharp ridge.

In 1884 Meunier [24] referred "Coahuila" to his Caillite group whose other representatives were distinguished by peculiarly beautiful Widmanstätten figures. In 1893 he [45] formed a distinct group "Coahuilite" for Coahuilin characterized by 4 per cent of nickel and, in comparison with Braunin, of different grain and color, less solubility in acid, and absence of rhabdite. Santa Rosa (1850), on the contrary, he describes as consisting of Braunin with rhabdite. In 1886 Huntington [30] stated that the etching lines of Coahuila are distinguished, under the microscope, from Widmannstätten figures, as they show for example in Butler, only by greater fineness; besides hexahedral cleavage, octahedral also occurs, and the etching lines run parallel as well to the edges of the cube as to those of the octahedron. Between irons with typical Widmannstätten figures and those with Neumann lines all gradations are in his opinion present. In the following year he [33] determined the specific gravity of 10 different specimens of the same block and obtained between 7.204 and 7.867. He concluded from the figures obtained that one could not, as Hidden had done, depend upon specific gravity to distinguish meteoric irons. This is self-evident indeed when one considers the irregular distribution of the subsidiary material even if, in the other experiments, material free from foreign substances was employed for the determinations. Judging by the above large differences this seems not to have been the case in a single instance.

In a further work Huntington [35] made the observation that the Butcher iron is distinguished by small, plane, brightly glistening faces of at most 10 mm. in size, which may be compared to interpenetrating twins of two hexahedrons and which show a very distinct striping parallel to the sections of all the faces. Since Sanchez Estate, relative to its cleavage, behaved otherwise, he thought it could not belong to the same fall, as was formerly held by him.

Finally Huntington described a large section of the Butcher iron in the Harvard collection which showed very prominent Neumann lines, but also showed Widmannstätten figures upon a band-like area running through the thickest portion of the block. The etched surface of a still larger section of the same block he stated had an appearance comparable to that of a frosted pane of glass with a crystalline formation increasing from the outside toward the interior. He stated that one could easily obtain sections of smaller circumference which showed only Widmannstätten figures, Neumann lines, or a granular structure. This difference in structure he accounted for by the more rapid cooling of the peripheral than of the central portions. Although large sections of the Butcher iron are tolerably well distributed no similar observation has yet been mentioned.

Derby [49] was of the opinion that the etching lines observed and described by Huntington correspond in part with his "Bendego lines," that is, they answer to the projection of the faces of a hexakis-octahedron.

Hartley and Ramage [50] made a spectroscopic analysis of Coahuila. Davison [51] noted 0.0023 per cent of platinum, which was apparently accompanied by iridium.

Analyses.

I. Hacienda de Santa Rosa; total analysis by Wichelhaus. The low percentage of Ni, Co is due to precipitation by barium carbonate.

II. Santa Rosa (Lupton's iron).

III. Bonanza; Shepard. White grains, as insoluble residue, about 0.01 per cent. Specific gravity, 7.825.

IV. Butcher iron; Smith. Specific gravity, 7.692.

V. Daubréelite from Butcher iron; Smith. Specific gravity, 5.01.

	I	II	III	IV	V
Fe	96.07	91.86	97.9	92.95	20.10
Ni	3.26	7.42	2.1	6.62	.....
Co	0.55	0.50	trace	0.48	.....
Cu	.....	0.00	.....	trace	.....
Mg	.....	.....	trace	.....	.....
P	1.05	0.27	±0.08	0.02	.....
Cr	.....	.....	trace	.....	35.91
S	.....	.....	.....	.....	42.69
	100.93	100.05	100.08	100.07	98.70

Of the above blocks only Hacienda St. Rosa and the Butcher iron have been sufficiently described to make certain their relation to the hexahedrites, but Fletcher's consideration of the subject leaves no doubt that they originated from one fall, while the data of Hamilton and Shepard on the one hand and of Butcher on the other, in many points—especially in the matter of the estimated weight, the distance from the place of discovery to Santa Rosa, and in the description of the neighborhood—differ not unessentially from one another. Santa Rosa is to be especially considered as the place of discovery since, according to Hamilton, Veatch, and Butcher, masses of iron have repeatedly been brought to the town since the year 1837.

The following data refer solely to the Butcher iron.

The Butcher iron shows distinct hexahedral cleavage and etching lines which are of equal distinctness, but of very various length. Some systems may be followed over an entire section surface of 20 cm., while others attain only a length of 5 mm. or fall for the most part considerably under these limits. Moreover the distribution is different. Upon one part of the etched surface both sorts are to be found, the shorter especially being very abundant and lying close together; here occur at the same time, in considerable number and uniformly distributed, etching pits and rhabdites which produce an unusually lively, oriented luster. Upon other parts of the etched surface, and penetrating the former in very irregular finger-like areas, are long etching lines massed together in bundles. The short twin lamellæ are wanting, as well as etch pittings and rhabdite, and the luster is a dull satin gloss, but, as it seems, of the same orientation as that of the other portion of the etched surface; that is, the reflection is strongest in each case in the same position with reference to the light. Nevertheless the two portions are sharply distinguished from one another in consequence of very different luster. The extremely fine rhabdites are mostly under 1 mm. in length but occasionally reach 4 mm. They run parallel to each other in two directions. In the proper position with reference to incident light they appear as extremely fine, glistening streaks. Where they occur together with short twin lamellæ, within the dull portions, both are surrounded by a small bright area whose luster coincides, in respect to strength and orientation, with that of the principal part of the nickel iron, so that here small dark specks lie in a dark field. The same is true of the troilite which, as a rule, is bordered by fine schreibersite and frequently contains plates of daubréelite. The Butcher irons are distinguished among all meteoric irons by the abundance of the latter mineral (daubréelite), scarcely a single piece, even of the smallest dimensions of the irons, being entirely free from it.

The Butcher irons take an extremely weak permanent magnetism and behave therefore like soft iron, which also occasionally shows traces of coercive force. Whether this is a consequence of artificial heating, as I formerly conjectured, may be left undecided. The specific magnetism was determined by Leick as 0.085 absolute units per gram.

By dissolving a large piece (160 grams) in very dilute muriatic acid grains of chromite and silicate were observed among the subsidiary constituents, but both in very small masses. The dimensions of the isolated rhabdites agree quite closely with those of Walker County, although they may be a trifle greater in diameter. Most of them are between 0.003 and 0.013 mm. thick, the observed boundaries (0.0015 mm. and 0.035 mm.) being only seldom attained. If now a large part, in fact apparently the largest portion obtained by isolation on account of the ready divisibility, be broken at right angles to the longitudinal dimension the thinner needles are in general the longer. Yet many crystals bounded at both ends by pyramid faces have a length of only 0.05 to 0.07 mm. Two pyramids, one sharper and the other more obtuse, are at times accompanied by the base. A few crystals are differently formed at both ends so as to suggest hemimorphism, and sometimes the pyramid faces appear to be incomplete in number. This recalls the observation of Hlawatsch, who described thin rhabdite needles from a furnace product with only two pyramid faces on the ends, so that he regarded the crystals as hemihedral.

Analysis (Cohen):

Fe	Ni	Co	Cr	P	Insoluble	
94.82	5.62	0.60	trace	0.29	0.06	=101.39

Specific gravity, 7.8678.

Mineralogical composition.

Nickel iron	98.344
Rhabdite	1.615
Daubréelite	0.027
Carbon	0.011
Chromite and silicate grains	0.003
	100.00

The Butcher irons are chiefly preserved in the Harvard collection. Huntington [32] lists the following individuals: 317 kg., 249 kg., 159 kg., 22 kg. In addition he lists a number of slabs.

Other specimens of Coahuila are widely distributed.

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Cocke County. See Cosby Creek.

COLFAX.

Colfax township, Rutherford County, North Carolina.
Here also Ellenboro.
Latitude 35° 18′ N., longitude 81° 47′ W.
Iron. Medium octahedrite (Om), of Brezina.
Found, 1880; described, 1890.
Weight, 2.2 kgs. (5 lbs.).

This iron was found, according to Eakins,[1] in the spring of 1880 or 1881 (latter part of 1880) by Amos Franklin while working on the farm of Mrs. E. W. Dedmon, of Colfax Township, Rutherford County, North Carolina. As it was found on the ground immediately after plowing it had evidently been turned up by the plow. It was thrown on a wood pile near by and frequently beaten with an axe. A small piece was broken off February 7, 1890, and sent to Dr. Stuart W. Cramer, of the U. S. Assay Office at Charlotte, N. C., who identified it as meteoric iron.

Kunz [2] describes the mass as weighing 72 Troy ounces, which would equal 2,240 grams, or about 5 pounds avoirdupois, and as having the size and shape of a double gourd with three or four indentations. Eakins [1] gives the length as 150 mm., the diameter of the ends as 75 mm., and that of the middle as 50 mm. He also states that the iron etches readily, and that Widmannstätten figures showed on a polished face before etching. Kunz [2] states that octahedral cleavages are also visible.

Analyses: I and II, Cramer;[2] III, Eakins.[1]

	I	II	III
Fe	87.69	89.22	88.05
Ni	11.26	9.37	10.37
Co	.62	.53	.68
Cu	.05	.04	.04
P	.19	.19	.21
S	.10	.08	.08
Si	.03	.01	.02
	99.94	99.44	99.45

About half the mass is preserved in the Field Museum collection; the remainder is somewhat distributed.

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Collin County. See Mackinney.

Colorado. See Russel Gulch.

Concepcion. See Adargas.

Coney Fork. See Carthage.

COON BUTTE.

Coconino County, Arizona.
Latitude 35° 10′ N., longitude 111° 7′ W.
Stone. Breccialike gray chondrite (Cgb) of Brezina.
Found 1905; described 1906.
Weight, 2,789 grams (6 lbs.).

This meteorite was found by Messrs. D. M. Barringer and S. J. Holsinger on June 24, 1905, about 1 mile west of Coon Butte. It is described by Mallet[1] as follows:

The specimen, as received by me, was pyriform, with a roughly triangular cross section bounded by two approximately flat surfaces (one larger than the other) inclined at about 60° or 65° to each other and united by a third, irregularly curved convex surface. It was a good deal larger at one end than at the other. The general surface was smooth, but indented at places with the characteristic shallow pittings, like thumb prints on a lump of sculptor's modeling clay, which are seen on so many meteorites. One presumably rather large piece had been broken off from the smaller end, and two other much smaller fractures appeared at and near the larger end. Measuring the mass as it lay on the larger, approximately flat face, the maximum length was about 14.5 cm., maximum width about 11.8 cm., and maximum thickness about 8.9 cm. The weight of the specimen as it reached me was 2,789 grams. There is an external oxidized crust, generally of dark, blackish brown color, with patches of redder brown, for the most part very thin, not exceeding 0.5 mm. in thickness; at some points the oxidized material runs in to a depth of 7 or 8 mm. A surface of fracture shows a gray mass of not very well-defined chondritic and brecciated structure, with numerous little spots of iron-stained yellowish brown color, including lustrous points of metallic iron; the general appearance like that of the Pultusk meteorites of January 30, 1868, but without the glossy black crust of these stones. There is a still closer resemblance, both of crust and fractured surface, to the meteorites from Ness County, Kansas. From the general appearance of the surface of fracture, I am inclined to class this specimen as Brezina's breccialike gray chondrite (Cgb). The specific gravity of the whole mass, taken by suspension in water at 15° C., was found to be 3.471, which is sensibly less than the results of calculation from the constituent materials found by analysis, indicating some lack of compactness in structure.

George P. Merrill, head curator of geology at the U. S. National Museum, who has given much attention to the petrographic study of meteorites, very kindly undertook to have thin sections made of some frágments I sent him, to examine these under the microscope, and to secure photomicrographs of some of them. The notes with which he has favored me are as follows:

"Aside from its metallic constituents, the stone consists mainly of enstatite and olivine. The enstatite, which is largely in excess, occurs in granular form without distinct crystal outlines and also in chondrules of the usual fan-shaped radiating and granular structures. In the larger forms of the single crystals a condition of molecular strain is manifested by the manner in which, between crossed nicols, the dark wave sweeps over the surface. Such a condition, it may be stated, is not uncommon in stony meteorites, though its full significance seems not to have been realized.

"The olivine likewise occurs in granular form and in that of chondrules with the characteristic barred or grate-like and, more rarely, porphyritic structures. Except where stained by a recent oxidation of the ferruginous constituents, both minerals are colorless or but slightly gray.

"In addition to the mineral above described, is a completely colorless isotropic substance occurring, as a rule, with no crystal outlines, but rather filling interspaces as would an interstitial glass. It is sometimes quite free from inclosures or, again, includes numerous silicate granules and opaque metallic particles. Rarely does it show anything suggestive of cleavage. Excepting in its lack of crystallographic outlines, the mineral is similar in all respects, as far as appearance goes, to the maskelynite of the Shergotty (India) meteorite, and such I shall have to assume it to be. It is altogether too small in amount to permit a satisfactory chemical determination, though with more material a microchemical test might be made which would go a long way toward settling the problem.

"The chondritic structure of the stone is not strongly marked, and the individual chondrules are themselves almost invariably of a fragmental nature. The structure, as a whole, is not unlike that of the Ness County, Kansas,

stone, and hence, if we follow Brezina, would be placed in the group of intermediate chondrites brecciated (Cib). As, however, I have examined this stone only in thin sections, none of which includes an area of above 10 mm. square, it is possible that further study might relegate it to the Cgb group, of which the Pultusk stone is a well-known representative."

The chemical analysis was found to be somewhat troublesome, particularly in regard to the distribution of the iron present in several different chemical conditions. The greater part of the metallic nickel-iron, accompanied by some schreibersite and pyrrhotite, was separated from a pulverized sample of about 50 grams, free from crust, by means of a magnet, but is was not possible to obtain complete separation in this way, so that a small proportion of silicates had to be deducted from the magnetically separated part, and a small proportion of the constituents of the nickel-iron, schreibersite, and pyrrhotite to be in like manner deducted from the siliceous part of the mass dissolved by acid. The part left by the magnet was digested with hydrochloric acid of 15 per cent strength for three days at a moderate heat, and thus a general separation of the decomposable silicates was effected, but several determinations of particular constituents had to be made on individual portions. Hydrofluoric acid was used to obtain the alkalies, and the same reagent, with exclusion of air, to secure a determination of ferrous iron.

The following statement gives the general result reached:

Enstatite	44.73
Olivine	33.48
Maskelynite (?)	6.87
Nickel-iron	8.63
Iron rust	3.03
Schreibersite	.76
Pyrrhotite	2.14
Chromite	.08
	99.72

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COOPERTOWN.

Robertson County, Tennessee.
Latitude 35° 30′ N., longitude 87° 2′ W.
Iron. Medium octahedrite (Om) of Brezina; Caillite (type 18) of Meunier.
Known since 1860; described 1861.
Weight, 17 kgs. (37 lbs.).

This meteorite was first described by Smith [1] as follows:

This mass of meteoric iron came into my possession during the month of December, 1860, being sent by Professor Lindsley, of Nashville, Tennessee. It was discovered by Mr. D. Crockett near Coopertown, in Robertson County, Tennessee. The time of its fall is not known. Its weight was 37 pounds. Its form was wedge-shaped; and its extreme dimensions were: Length, 10 inches, breadth, 9.5 inches, and thickness, 5.5 inches. Its specific gravity is 7.85. On cutting through the mass a nodule of sulphuret of iron was discovered about one-fourth of an inch in diameter, and there are doubtless others in its interior. The iron, on analysis, furnished:

Fe	Ni	Co	Cu	P	
89.59	9.12	0.35	trace	0.04	=99.10

Brezina [2] in 1885 classes Coopertown in the Toluca group, and states that, corresponding to the greater breadth of its lamellæ (1.2 mm.), it shows a more swollen appearance.

Huntington [3] gives an illustration of an etched plate and describes a specimen which he regards as showing octahedral, dodecahedral, and cubic plates.

Meunier [4] describes the structure as follows:

This iron yields larger figures than ordinary caillite without, however, taking on the character of bendégite. The kamacite bands are frequently 2 mm. thick. The taenite is relatively scarce. The plessite is very pure. There is no pyrrhotine visible; however, dissolving in acid disengages hydrogen sulphide.

The meteorite is distributed, the Harvard collection possessing the largest quantity, 2,065 grams.

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4. 1893: MEUNIER. Révision des fers météoriques, pp. 52 and 56, 57.

COSBY CREEK.*

Cocke County, Tennessee.
Here also Cocke County and Sevier County.
Latitude 35° 45′ N., longitude 83° 10′ W.
Iron. Coarse octahedrite (Og) of Brezina; Arvaite (group 7) of Meunier.
Found 1837; described 1840.
Weight reported about 950 kgs. (2,000 lbs.).

This meteorite was first described by Troost [1] as follows:

During my excursions through East Tennessee I had seen small fragments of native iron and had heard of large masses of it which were believed to be silver. It being considered a precious metal all that was known about it and the place where it was found were kept a profound secret. Some less prejudiced inhabitant at last became acquainted with the nature of the metal and its real value was made known. To the politeness of Col. Micajah C. Rodgers, of Sevierville, I am indebted for a considerable quantity of it; and the Hon. Judge Jacob Peck, of Jefferson County, has also presented me with some small fragments. I am thus enabled to lay a description of this singular substance before the scientific public.

Having ascertained, as appears from the analysis below given, that this iron contains nickel the mass must be considered of meteoric origin; but it differs from most of the masses of meteoric iron hitherto described. The original weight of it is said to have been about 2,000 pounds. The portions that I have seen (as well as those which are in my possession) present a singular heterogeneous mixture of metallic iron, carburet of iron or graphite, sulphuret of iron (pyrites), and hydroxide of iron, the latter brown and yellow; in some parts all four ingredients form a kind of homogeneous mixture.

The most abundant constituent, however, is the nickeliferous iron, and it composes about 95 per cent of the whole mass. It has partly a crystalline structure and is in part composed of grains or globules of various sizes and forms, merely agglutinated together, or sometimes separated by a thin, flexible, highly polished pellicle of graphite. The crystalline part is composed of laminæ of various thickness in the form of equilateral triangles, which are separated from each other by very thin flexible pellicles, as mentioned above respecting the grains.

I expected to find these triangular laminæ placed in such position as to form octahedrons, or showing a cleavage parallel to the sides of a regular octahedron, but this is not the case, as the cleavage gives a regular tetrahedron. I have one of these forms which is about an inch from base to apex.

The metallic iron is also dispersed in small irregular-shaped masses through a hard, compact, brown hydrated oxide of iron. Throughout this the iron is also dispersed in invisible grains, to be detected only by the magnet, which attracts them when the substance has been reduced to powder.

This iron is malleable. I have in my possession a horse-shoe nail which was made of it without having undergone a previous preparation, but it is harder and whiter than common wrought iron. This hardness and color may be owing to a small quantity of carbon which it contains, or perhaps to the nickel; in its natural state, however, the color of the iron differs much in different parts. In some it is black and has no metallic luster; in others it has a brilliant metallic luster and is then always much whiter than steel or common iron. It is then but little susceptible of being tarnished when exposed to the action of the air; the black part being merely tarnished may be rendered white by a file; in some places it is covered with a kind of black varnish.

The substance which constitutes the greatest part of the remainder of the mass is graphite. This substance is not easily distinguished from the common graphite or plumbago, except that it is a little harder than the common granular and compact varieties, and is also rather blacker and makes a finer, blacker, and more distinct line upon paper than common plumbago. When rubbed with a hard body it assumes a bright metallic luster. It is not pure graphite, but rather a mixture of graphite and metallic iron. The iron can be partly removed by a magnet when the graphite is reduced to powder, but a considerable portion remains mixed with the graphite which, when acted upon with hydrochloric acid, is dissolved with a brisk effervescence of hydrogen gas.

The sulphuret of iron, pyrites, occupies the smallest portion of the mass. This pyrites is not attracted by the magnet, nor does it seem to act upon the magnetic needle. It can easily be cut with a knife and is consequently softer than common pyrites. It does not give sparks when struck with steel—another property which distinguishes it from common pyrites. It is easily soluble in dilute hydrochloric acid, with a brisk evolution of sulphuretted hydrogen gas, leaving a mixed powder of white and black in the fluid. It has a more or less sublamellar structure in which no regularity can be perceived, and a color between bronze yellow and copper red, often tarnished.

The hydroxide of iron which forms part of this mass is a heterogeneous mixture of the varieties of the ore generally known under the names of brown iron ore and yellow ocher, and resembles this terrestrial mineral. Its color is generally brownish black, passing into liver brown. The external surface of the mass is covered here and there with the yellow earthy variety (yellow ocher); how far this covering extended I am not able to say, as the mass was too roughly handled before any part of it came into my possession. Its fracture resembles that of the common compact brown iron ore. The blackish brown variety is so very hard that the best file is immediately dulled upon it and leaves particles of the steel on the surface of the ore. Nevertheless, the whole is not of uniform hardness; a part, particularly the liver brown, being scratched by the file.

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* The term has usually been spelled Cosby's Creek, but the official spelling is as above.

Some small cavities in it are lined with lamellar crystals resembling those of white pyrites.

This hydroxide, which serves as a matrix of the metallic iron, is not, judging from my specimens, abundant in the interior of the mass but the exterior of the mass is entirely made up of it. At some places it is about 1 inch thick, while at others it is no more than one-quarter of an inch, showing here and there small points of the metallic iron piercing through it.

Such are the character and appearances of this mass of the date and circumstances of whose fall nothing is known. It was accidentally discovered near Cosby Creek in the southwestern part of Cocke County, east Tennessee and, as I mentioned above, was considered as silver ore. Indeed, there is yet a fragment of it in the hands of an inhabitant who asks for it $1,500, a sum which would be some hundred dollars too much if it were pure silver.

CHEMICAL CONSTITUENTS OF THE DIFFERENT PARTS.

1. *Metallic iron.*—One hundred grains of the metallic iron were dissolved in diluted hydrochloric acid leaving a residue of half a grain of a black powder, similar to that obtained from the graphite. This solution, being treated with nitric acid to convert the protoxide into peroxide, was precipitated by pure ammonia. The precipitate being washed and ignited gave 124 grains of peroxide =87 grains of iron. The ammoniacal solution gave 16 grains of protoxide of nickel =12 grains of metallic nickel with a trace of cobalt; loss, half a grain.

Iron	87.0
Nickel	12.0
Carbon	0.5
Loss	0.5
	100.0

2. *Graphite.*—Fifty grains of the graphite, being pulverized and freed by a magnet from intermixed iron, were acted upon with diluted hydrochloric acid. An effervescence took place, with explosion of hydrogen gas, owing to metallic iron which was so intimately mixed with the graphite that it was not attracted by the magnet. After the effervescence ceased it was heated in order to dissolve everything that was soluble. The insoluble part was washed and dried; it was pure carbon and weighed 46.5 grains.

The hydrochloric solution, being treated with nitric acid to convert the protoxide of iron into peroxide, and precipitated by ammonia, gave peroxide of iron equal to three grains of metallic iron. The filtered solution was treated with pure potassa and a hardly perceptible gray flocculent precipitate was obtained, so that this iron was free from nickel.

Carbon	9.5
Iron	3.0
Loss	0.5
	100.0

3. *Sulphuret of iron.*—A small fragment of the pyrites was dissolved in diluted hydrochloric acid under a brisk effervescence of sulphuretted hydrogen gas. Part of it was insoluble; this, after being washed and dried, was exposed to heat, by which the sulphur was sublimed, leaving a black powder. The quantity used was too small to determine the proportion; it is composed of sulphuret of iron and carbon.

4. *Hydroxide of iron.*—The hydroxide of iron lost about 17 per cent by being heated and had all the characters of a similar residue from brown ironstone or hematite.

Shepard [2] gave a further account of the meteorite as follows:

Having been informed by Mr. Edward C. Herrick that a specimen of meteoric iron existed in the museum of the East Tennessee University of Knoxville, I addressed a letter to President J. Easterbrook of that institution, desiring information upon the subject, and if possible, a fragment for analysis. The president was kind enough to transmit to me a specimen for examination, together with the following notice of its origin. "It is a portion of an irregular mass, which was given me about five years since. The mass, as you have been informed, was discovered in Cocke County. The proprietor resisted for some time all importunities to discover where it was, believing it to be some metal of great value. I assured his agent that it was native iron, and probably meteoric. After he became satisfied of its character, many individuals examined it in place. It was entirely insulated on the surface of the ground, and weighed about 700 or 800 pounds. Specimens were obtained from it and dispersed through the country. It was my intention to have purchased and transported the entire mass to Knoxville, until I learned that Dr. Troost, geologist to the State, had obtained the refusal of it. He has since conveyed it to Nashville."

It turns out, therefore, to be a portion of the mass described by Dr. Troost.[1] Having been presented by Dr. Troost with several fragments, as illustrative of the portion in his hands, I found on comparing them with the specimen sent by president Easterbrook, that the latter differed very much from the former, in external appearance. Unlike to them, it was to a degree free from the plumbaginous and pyritous admixtures with which they abound. It agreed with them, however, in possessing a coarsely crystalline texture. Its proportion of nickel falls much below that quoted by Dr. Troost; but this is a circumstance which I have found to hold true in the Texas iron, wherein my experiments have proved the nickel to vary from 3.2 to 9.6 per cent. The specific gravity of the mass was 6.222.

I. Ten grains were treated with nitrohydrochloric acid. The metal was rapidly taken into solution; but a blackish residuum remained. This was treated by itself with heated nitrohydrochloric acid for several hours. The quantity was thereby reduced; but a few black grains (of the size of fine-grained gunpowder), together with numerous shining scales, still remained in the fluid. These were well washed and dried. They weighed 0.01 gr. The acid solutions were mingled and precipitated by ammonia in large excess. The fluid stood along with the precipitate for six hours at a temperature of nearly 100°. The peroxide of iron was then separated and thoroughly washed for several hours with tepid water. The washings and the original ammoniated liquor were mingled and boiled; after which they were transferred to a glass bottle and decomposed while hot by potassa. The clear liquid was separated, after twenty-four hours, by filtering (the hydrosulphate of ammonia, when added to it, produced no change in color). The precipitated oxide of nickel was ignited and weighed 0.6 gr. The peroxide of iron after ignition weighed 13.4 gr. We have then—

Iron	93.80
Nickel	4.66
Undissolved	0.10
	98.56

A second and parallel analysis was conducted upon 30 grs., the results of which were as follows:

Peroxide of iron	40.30=Iron	28.210=94.033	
Protoxide of nickel	1.68=Nickel	1.333= 4.444	
Undissolved	0.03=Undissolved	0.030= 0.100	
			98.577

The undissolved matter from both the analyses was examined by the microscope. It was principally in soft black grains, along with which were a few brilliant scales of graphite. Both the grains and the scales were attracted by the magnet. On grinding them in a mortar, they gave a brown powder, in which little particles of metallic iron were felt beneath the pestle. The powder was then treated with nitrohydrochloric acid, whereby the iron was dissolved out, leaving behind a fine, blackish brown powder.

II. Fifty grains of the meteoric iron were now subjected to the following analysis. Distilled water was boiled upon the iron for a few minutes. A portion of the fluid, separated from the iron, gave with nitrate of silver no precipitate; another portion gave with chloride of barium a slight precipitate. The iron was then treated with nitrohydrochloric acid. The action of the acid ceased after a few hours, numerous flakes of the iron remaining in the flask, as if insoluble. On the application of heat, however, the action was renewed. More acid was subsequently added and the digestion continued, until the solution was apparently at an end. The black grains and shining scales were separated, washed, dried, and rubbed in a mortar as above. The blackish-brown powder (having metallic iron intermixed) was treated with hydrochloric acid; a brisk effervescence from the evolution of hydrogen immediately ensued. When the action had ceased, the fluid was decanted, and the residuary blackish-brown powder transferred to a small platinum capsule, in which it was ignited for a few moments with exposure to the air, in order to burn off the free carbon. It was then ignited to low redness with twice its weight of nitrate of potassa. Water was boiled on the fused mass; a portion of the blackish powder still remained. The solution was colorless, showing the absence of chromium. Nitrate of silver produced in it a pale, yellowish precipitate of phosphate of silver. The residuary brown powder was now ignited for several minutes with dry carbonate of potassa; water was boiled upon the same; the solution was decomposed by nitric acid, and then evaporated to dryness, after which the addition of water brought flocks of silicic acid into view. The results of this analysis gave—

Iron	93.80
Nickel	4.66
Carbon, Silicon, Phosphorus, along with grains of iron and nickel alloy	0.10
Oxygen, sulphate of iron, sulphur, moisture, and loss	1.44
	100.00

Since my return to New Haven, I have paid some attention to another specimen of meteoric iron from the same mass with the above, which was kindly afforded me by Dr. Troost. On breaking it to obtain a fresh fracture, the regular crystalline structure showed itself on the largest scale. The clean surfaces were intersected by layers of brilliant magnetic iron pyrites, varying in thickness from one-sixteenth to one-fourth of an inch, whereby a series of trihedral and rhombohedral areas of various sizes were produced. These regularly inclosed spaces were mostly black, from the diffusion of a sooty form of carbon between the plates of the meteoric iron. The contrast between the areas and the separating layers of pyrites was consequently rendered more striking. Besides the distribution of the pyrites in plates or veins, it also occurs in balls and almond-shaped masses, sometimes half an inch or more in thickness. The structure of these is concentrically laminar, the laminæ being often separated by iron and carbon. The pyrites form nearly one-sixth of the mass. Dr. Troost presented me also with several loose balls of the shape of the pyrites masses, which to the eye seem composed of little else than carbon, concerning which a few remarks will presently be subjoined. None of these balls are found embedded in the specimen I am more particularly describing.

If we except the bright projecting edges of the pyritic veins, the Widmannstätten figures produced by etching with dilute nitric acid on polished surfaces in directions of cleavage in this iron are by no means striking. Little channels and waving striæ, bright at bottom and dull at top, are indeed brought into view; but these are so minute and irregular as to require the use of a microscope before their true character is detected. If, however, cross sections to the above surfaces are polished and etched, we then see the delicate, silver-white lines which are so common in other meteoric irons. As this iron is cleavable into layers of extreme tenuity, I selected a number of layers whose edges were the brightest on these etched surfaces, for analysis; my inquiry being chiefly to ascertain whether the ratio of the iron to the nickel was the same here as in average portions of the mass. I was satisfied that it contained no greater per cent of nickel than I had found in the analysis made at Charleston.

In polishing some of the carbonaceous balls above alluded to, minute grains of pyrites were rendered visible; and others still smaller, which had a more silvery whiteness. A small fragment was crushed under water in a mortar, and yielded white malleable grains, similar to tin. Portions of the mass were then acted upon by the blowpipe along with carbonate of soda, when the most satisfactory evidence of the presence of tin was afforded. I found also that (by treating these carbonaceous masses with nitric acid and subsequently igniting with potassa) they contain silicon and magnesium in decided proportions, with traces of aluminum. Their shape and mode of occurrence served to suggest an analogy they sustain to the embedded grains of olivin in the Pallas iron of Siberia, and the Otumpa iron of South America, the difference in the case being that in the Tennessee iron no oxygen was supplied for the combustion of the silicon, the magnesium, the aluminum, and the iron.

Partsch [3] described the piece in the Vienna Museum as follows:

Compact and dense native iron with little pyrrhotite and (according to Professor Troost) much graphite. We have only some small oxidized fragments easily disintegrating like that of Asheville. The crystalline structure is shown by the well-marked Widmannstätten figures on etched surfaces.

Shepard [4] gave the following additional notes:

For our earliest notice of this truly wonderful locality of meteoric iron we are indebted to Doctor Troost and myself. The history of this locality is still further illustrated by the following particulars, derived from two letters from Judge Jacob Peck, of Jefferson County, Tennessee, the one dated July, 1845, and the other December of the same year. Extract from the former, which was addressed to Dr. J. H. Kain, of this city: "The large mass of meteoric iron found some years ago in Cocke County (on a creek called Cosbys), fell into the hands of some persons who tried to break it with sledge hammers, but not succeeding, they placed it upon what is here called a 'log-heap,' where, after roasting for some time, it developed certain natural joints of which advantage was taken with cold chisels and spikes for its separation into fragments. These were put into a mountain wagon and transported 30 or 40 miles to a sort of forge and there hammered into 'gun scalps,' and other articles of more common use. Some remnants of the mass fell into the hands of Doctor Troost. The original mass was one of rare character and ought to have been preserved entire. Much of it was composed of large and perfect octahedral crystals. Its weight was about a ton. Another mass weighing 112 pounds was found near the locality of the larger one. This also was malleable, very white, and easily cut with a sharp instrument. It was picked up by a mountaineer who, supposing it to be silver, asked $1,500 for it. After retaining it for some years he finally sold it to a friend of mine for a small sum, who transferred it to Doctor Troost."

Extract from the letter of December, 1845, to myself: "The weight of the mass has been variously estimated, but I am certain it was never weighed prior to its being broken up. It was probably about 2,000 pounds. In figure it was an oblong square block. I saw several very regular octahedral crystals that had been detached from the exterior angles of the mass. I had formerly supposed that the whole of it had been taken to Lary's forge, in Sevier County, and the greater part of it there wrought into 'gun scalps'; but very recently I have been informed that part of it was taken to the forge of Peter Brown in Green County, and there forged. I understand that a man by the name of McCoy had a neat bar forged from it for making a gun barrel which, to use the expression of Brown's son, 'was as bright as silver.' In the conversation young Brown informed me that he thought a piece of the iron in its natural state still remained. On searching, it was found by a little girl of the family. It weighs rather more than a pound and had been preserved by the family as a nutcracker.

"The great mass was found on a hill, or rather on an offset of an eminence, at about 100 feet above the bed of Cosby Creek. I was at the place after the mass was taken away. The formation was a hard clay slate, and very little impression was left at the spot except some stains of red oxyd of iron. McCoy, who claimed to be the owner of the land, took me there under the impression that I should be able to aid him in discovering a mine of pure iron near the spot, especially as the mass of 112 pounds was found in the same immediate vicinity. The search of course was to no purpose. The mass of 112 pounds appeared to me to be identical in character with the fragments I have seen of that supposed to weigh a ton."

The specific gravity of this iron, as given by Partsch, is 7.26. I have found that of the included magnetic iron pyrites to be 4.454.

Joy [5] gave an analysis and description of the iron as follows:

The meteoric iron of which I made the following analysis was described in 1840 by Doctor Troost, of Nashville, in whose possession it is found. The mass weighing 112 pounds was discovered at Cosby Creek, Cocke County, Tennessee, after another iron mass weighing nearly 2,000 pounds and of very similar character had been found a little earlier in

the same neighborhood, which unfortunately was worked up to within 1 pound's weight. This iron is especially noteworthy because of its great similarity with the Arva iron described by Haidinger. At least this similarity was striking in the specimen found in the Royal Berlin Museum, as well as in a small fragment of 28 grams weight which was obtained from Sowerby in London. On the surface and to some extent in the body of the mass it is changed into pyrosiderite, which crumbles easily, in which frequently are found leaves of schreibersite, sometimes quite large and of a yellowish-white color with a metallic luster and flexible in texture, quite similar to that of the Arva iron. After etching a small, well-polished surface on this iron, a very noticeable marking of fine parallel lines appears, which is visible to the naked eye in the sunshine by the peculiar luster of the surface.

The small fragments of the Cosby Creek iron which served as the materials for this analysis were given me by Mr. Sowerby on the occasion of the former's last visit to London. They were all very much oxidized on the exterior.

The analysis gave the following results:

Fe	Ni	Co	P	Cu and Sn	Mn	Graphite	Quartz	S	
91.635	5.846	0.809	0.195	0.219	0.092	0.798	0.079	?	=99.673

Portion insoluble in hydrochloric acid, 3.21, consisting of schreibersite, graphite, and quartz.

Bergemann [6] also made an analysis as follows:

I undertook an analysis of this meteoric iron, which had already been examined by Shepard, as I possessed a broken fragment of 4 grams weight, which showed very distinctly the lamellæ that are insoluble in muriatic acid. I recorded the results of this analysis because they differ from those of Shepard. The specific gravity I found to be 7.257. The insoluble residue weighed 0.083 grams, equal to 2.075 per cent. No hydrogen sulphide was developed in the process of dissolving the material, and no metal was precipitated by hydrogen sulphide.

The residue mostly consisted of a black dust in which yellowish particles of a metallic luster were present in considerable quantity in the form of small scales and were easily removed with the magnet. The black amorphous powder weighed 0.0077 grams, burned readily when heated on platinum foil, and left a trace of a residue consisting of iron oxide. The particles removed by the magnet and freed from all carbon by washing possessed a gray color shading into brown and a specific gravity of 6.99.

The following figures were yielded by the analysis:

	Soluble.	Insol. Res.
Fe	90.096	1.802
Ni	6.521	0.183
Co	0.332	.....
P	0.021	0.068
C		0.175
		99.198

Reichenbach [7] made numerous observations upon the meteorite, the most important of which are as follows. In Study XII, page 458, he says:

If we consider * * * the North American Sevier, Caryfort, and Cosby, as well as Tejupilco and Bata, we find in all magnetic pyrites as large as walnuts, of a smooth rounded form, or in the form of sections of a cone. I also possess pieces of graphite of the size of walnuts from the Cosby meteorite which fall out upon crumbling this loose iron mass.

On page 460 he says:

I obtained from a large specimen of the Sevier meteorite a piece of pure iron sulphide as large as half a finger. It fell out in the process of cutting and had the form of a belemnite (arrow stone). In a cross section, at right angles with the axis, it showed distinct, concentric rings and the longitudinal section showed how these lay one over the other in the form of layers and scales along the entire length of the body. Such a case occurs seldom enough to make a sketch worth while (which is accordingly given in the text). It is very easy to see from this how the iron sulphide is formed and how it is arranged in crystalline layers around its core. The hatching shows the different directions of the foliation of each layer of pyrites. Only upon the first thin layer around the core is the foliation indistinct. But the entire cone was an indisputable product of free crystallization proceeding intermittently.

In Study XV, page 111, he says:

If we compare further the coarser meteoric irons we see the *Trias* recurring, especially in Cosby, the light gray beam-like iron, the reddish fawn-colored band iron, and the grayish plessite, although all much modified. The beam iron indeed shows its lines or hatching distinctly but coarser. On the other hand, this is no longer formed in such regular bars, no longer developed in the beautiful rectilinear and parallel intersections, but is sprawled out in irregular, puffy, and nodular masses in which the eye is able only with difficulty to perceive, in the larger formations a longitudinal extension in contrast with breadth and thickness. There is little of the isabel-yellow colored band iron, it is so thin that it must be sought for with the glass. The plessite is brighter, approximates the beam iron in color, remains always without hatching, and is by this single characteristic to be distinguished from the latter.

He further described the structure, pp. 127–129, as follows:

I have followed this granulation of the kamacite most carefully in the case of Cosby. Pieces of this iron meteorite are so incoherent and disrupted throughout its entire substance that, when it is only lightly struck with a hammer it falls apart into a sort of iron garble, which consists of many sided crumbs and grains, all covered with a thin efflorescence of protoxide of iron. Such garble in abundance has reached Europe from Cocke County, and a good portion of it came into my possession. It apparently owes its origin to the fissuring, which is bound up with its fine granular division; if individual crumbs be further merely struck upon a wooden base, many of them, without the use of force, fall apart into still smaller particles, and if the process be continued, it will, if properly conducted, break up the kamacite into its ultimate individual grains.

I selected many individual grains from this garble, and after grinding them in all directions and in manifold variations, polished and etched them. In all cases I obtained the hatching of the foliation and the netting of the grains. These were so distinct here that in most cases they were visible to the naked eye. The phenomena were always the same upon all surfaces; if, where they were found visible upon beam fragments, the granules were ground and etched from above, from the side, or from beneath, the hatching was always found over all the ground surfaces and these subdivided by division lines into a mass of areas resembling a land map. It follows that the granules on all sides had the same characters, no preferable longitudinal direction, and accordingly were in all respects actual granules. Their coherence with one another in the case of Cosby Creek must be especially weak as compared with other meteorites, and accordingly a somewhat loose coherence pertains to those masses which consist almost entirely of kamacite. There is only one locality comparable in this respect with it, and that is its neighbor, Sevier. This also crumbles very easily, and my compatriots in America have accordingly frequently expressed the opinion that Cosby and Sevier are fragments of one and the same meteor. This is entirely wrong, however; these two meteorites are, mechanically and chemically, fundamentally different, as will be shown more particularly on another occasion. When I was investigating the iron-garble of Cosby I thought I had found a good occasion to discover pure kamacite and to be able to isolate and analyze it. I began to wash and purify it, but so many variations presented themselves among these grains that I was compelled to doubt whether it is possible to recognize beam iron that is unmistakable and pure enough for analysis.

In Study XVI, page 253, he says:

There are, as has been mentioned here before, certain of the Widmannstätten group of meteoric irons which occasionally have a loose coherence. They are easily divided, with only moderate striking, into crumbs which follow the natural cleavage. This often takes place in the line of the tænite plates, which become loosened and produce fissures. The kamacite and plessite then separate and the inner scales of the tænite then fall out of themselves. This happened in the case of Asheville, Sevier, and Cosby. Pieces of these fell apart almost of themselves, and disclosed isabel-yellow colored particles which were easily picked out and freed from all adhering matter.

On page 254 he gives the specific gravity of Cosby as 7.260. On pages 257 and 258 Reichenbach gives an analysis by his son of the entire *Trias* of Cosby, that is of the crude meteorite as a whole, which gave the following figures in two separate analyses:

Fe	90.125	89.324
Ni	9.786	10.123
Co		0.422
P	0.089	0.131
S	Trace.	Trace.
	100.	100.

On page 263 of Study XV, Reichenbach gives the specific gravity of the tænite as 7.428. In Study XVII, page 265, he states that the plessite of Cosby Creek closely resembles the kamacite, being distinguished only by its duller luster and absence of hatching. In Study XX, page 621, he states that iron sulphide appears upon the polished but unetched surface of meteorites in three colors. Of these he says (pp. 621–625) Cosby contains—

masses an inch in size and belonging to the first and by far the most numerous group, namely of bronze-colored, sometimes like polished, sometimes like dull undressed gun metal.

* * * * * * * * *

Cosby and some others have very bright sulphide which is sometimes hard to distinguish from the second class of brass-yellow color.

* * * * * * * * *

The third form, or whitish-yellow colored iron sulphide, is found well formed in Sevier (and others). Here it occurs with and adjacent to the first or bronze-colored variety, and indeed it embraces the latter, incloses it, and forms the intermediate member between the bronze colored iron sulphide and the Trias. It extends into the latter and forms patches in it, and shows its own color in marked contrast with both the others.

He also says, page 634, that he has—

well-defined cases in his collection where the whitish-yellow (third class) compound is not combined with pyrrhotite and does not envelope it, but is associated with another body—graphite—and surrounds large lumps of it as in other cases it does the pyrrhotite.

Of the graphite of Cosby Creek, Reichenbach says (Study XXI, p. 577) that he has two specimens, one—

of which weighs not less than 34 and the other 44 grams. The two fit together on the rough edges exactly and were, therefore, originally one piece, which weighed 80 grams, and, judging from the other broken surfaces, must have weighed 100 grams.

On page 579, he gives the specific gravity of the Cosby specimen, about a cubic inch in size, as 3.564 "which is considerably heavier than terrestrial graphite, apparently because of a small content of iron. * * * This graphite occurs frequently in company with magnetic pyrites." He gives a figure of the nodule, and on page 586 he states that he observed abundant and fine examples of iron glass in his specimen of Cosby.

In Study XXIa, pages 172 to 176, he says:

If meteoric iron (as Cosby, Arva, etc.) be subjected for several weeks to the action of very dilute acid (cold), it will gradually dissolve, and

* * * * * * * * *

there is obtained in this manner, with very dilute acid, a residue which makes up about 10 per cent of the meteorite of Cosby. * * * The black fine-grained powdery residue, amounting to 2 per cent of the original mass, obtained from the treatment of the above-mentioned 10 per cent residue with strong acid (applied with boiling heat for several hours) yielded from 4 to 5 per cent of phosphorus, besides iron and nickel. Sulphur was lacking in it.

* * * * * * * * *

Three grams of the 2 per cent residue above from the Cosby meteorite, immersed in concentrated cold hydrochloric-acid, was dissolved in two years time almost completely down to an extremely small remainder containing almost nothing but carbon. The same substance treated with the strongest acid, namely concentrated nitric acid or aqua regia (heated) quickly dissolved entirely.

* * * * * * * * *

In the tænite obtained from Cosby some sulphur was found, which is elsewhere lacking.

Rammelsberg[8] received from G. Rose a specimen of iron sulphide from the Sevier iron which contained particles of nickel-iron which "followed the magnet." He found by two analyses 1.5 and 1.9 per cent of nickel and such proportions of iron and sulphur as, by reckoning the nickel with the latter, gave iron sulphuret here also. The specific gravity of the iron sulphide in Sevier he determined to be 4.817.

Rose[9] describes the Berlin specimen of Cosby Creek as follows:

Many superficially oxidized octahedral fragments of this meteorite were received by gift from Professor Troost together with small pieces of graphite and troilite from the same. The pieces extraordinarily resemble those of the Arva iron; but the quantity of schreibersite is somewhat greater in one piece of Cosby Creek. On one piece graphite is mixed with troilite.

Rose also mentions a piece of Sevier County which he received from Reichenbach which he does not find to differ from Cosby Creek.

In 1864, Rammelsberg[10] analyzed the iron sulphide previously mentioned as obtained from Rose, and obtained the following result:

	1		2	
Residue	0.74	.....	0.60	.....
Iron	62.18	62.65	61.43	61.80
Nickel (Co)	1.94	1.96	1.55	1.56
Sulphur	35.14	35.39	36.42	36.64
	100	100	100	100

Smith[11] also gave an analysis of "troilite from Sevier," as follows:

	1	2
Iron	63.80	63.48
Sulphur	36.28	36.21

No trace of other elements was found.

Smith [12] made a detailed study of the graphite from one of the Cosby Creek masses as follows:

In this communication I call special attention to a large nodule taken from the very center of the Sevier iron, the largest that has come under my observation, and perhaps the largest known. It was detached from the iron entire and perfect in every respect. Its greatest length is 60 mm.; its dimensions in the other direction vary from 20 to 35 mm. The weight before it was cut was 92 grams. Its form is that of an irregular dumb-bell, flattened on one side and slightly nodular on the surface. Its color is plumbago-black, except at small places on the surface, where there is a little bronze-colored troilite. Its texture is remarkably close and compact, and it is cut readily by the saw, except when the tool encounters particles of inclosed troilite. Its structure and powder is not unlike that of the close-textured graphite of Borrowdale in Cumberland, England, and quite unlike the scaly graphite such as that from Ceylon or that found in certain cast irons.

Examined from the circumference to the center this nodule presents the following appearance: About one-fifth of the circumference of the section is made up of troilite with a thickness of 1 mm. The remainder of the section has all the aspect of graphite except in a few spots. In the nodule there is a small mass of troilite not unlike in form the entire nodule; it is 10 mm. long by about 5 mm. wide; it is not continuous from its circumference to its center, but the center portion is cut off completely from the exterior portion by a thin belt of graphite 0.5 to 0.75 mm. in thickness. Again on other parts of the surface small particles of troilite are to be seen.

The specific gravity of this graphite is 2.26, as determined on a piece in which no troilite was visible to the eye and after it was immersed in water and placed under the receiver of an air pump to abstract the air from its pores.

Chemical character of the graphite nodule.—When pulverized and heated from 100° to 150° C. in a short glass tube water is given off which is doubtless water absorbed from the air by the graphite. If heated a little higher and then brought close to the nose a slight empyreumatic odor is apparent; if heated still higher there is a slight odor of sulphureted hydrogen. If heated in the open air the carbon is burnt with difficulty, showing its true graphitic nature.

Treatment of the graphite by ether.—Very pure and concentrated ether was added to 2 grams of material in powder and rubbed up in a porcelain mortar, then poured into a small beaker, a little more ether was added, and the two allowed to remain together for 12 or 18 hours, the vessel being covered to prevent evaporation. The ether was then filtered off from the graphite, which was finally washed with a little ether. The ether was allowed to evaporate slowly in the uncovered beaker, placed where the temperature was about 33° C. After the ether had evaporated, long colorless acicular crystals covered the sides of the vessel, and some shorter ones were in the bottom. There were also some rhomboidal crystals and rounded particles. The solid residue exhaled a peculiar odor of an aromatic character, somewhat alliaceous. The quantity of these crystals was small, not exceeding 15 milligrams from 2 grams of the graphite. Heated on a piece of platinum foil, they fuse at about 120° C. Heated in a small tube closed at one end, they first melt and then volatilize, condensing in yellow drops that soon solidify leaving a carbonaceous residue. They are not soluble in alcohol, but very soluble in sulphide of carbon. Fuming nitric acid oxidizes the material and gives as one of the products sulphuric acid. The quantity was too small to admit an ultimate analysis, but it was very evident that sulphur was the predominating constituent, the remainder being carbon and hydrogen. These three elements may be combined, forming a peculiar sulp-hydrocarbon which in a previous note I called *celestialite*, or it may be sulphur containing a minute quantity of hydrocarbon that gives the peculiar odor and determines the somewhat singular form of crystallization of the sulphur, for these acicular crystals may be only elongated rhombohedrons.

Be the compound what it may, it is a matter of chemical and astronomical interest that a solid graphite nodule thus incased in iron should contain a sulph-hydrocarbon, or free sulphur and a hydrocarbon.

The graphite powder after treatment with ether was then treated with the bisulphide of carbon (which was redistilled just before use), and after standing two or three hours was thrown on a filter; the filtrate was evaporated to dryness, and the residue was a yellow solid; in this instance, as in the last, the quantity was small. This, when heated in the open air on platinum foil to a red dull heat, first melts at about the temperature that sulphur melts, and finally the sulphur is burnt off, leaving a carbonaceous residue. When heated in a tube it sublimes, leaving a black residue.

To all appearances this is the same substance, or mixture of substances, that was extracted by the ether, the ether not having exhausted the graphite in the first treatment.

Later Smith [12] oxidized the graphite of the meteorite.

In 1878 Smith [13] found daubréelite in the troilite of the meteorite.

In 1881 Smith [14] mentioned thin white metallic spangles from decomposed portions of the meteorite which contained 27 per cent of nickel and 73 per cent of iron. This was undoubtedly tænite.

Brezina [15] classed Cosby Creek in the Bendego group of coarse octahedrites. The width of the lamellæ he gave as 1.5 to 2 mm. The characters which he assigns to this group are as follows:

Lamellæ bunched, irregularly bounded, strongly hatched, with lively oriented sheen. Kamacite predominant; fields, combs, and plessite lacking or minute.

Huntington [16] noted the presence of tænite in the form of thin elastic foil separable from the meteorite. He [17] also gave the following description of the specimens of the meteorite in the Harvard collection:

Cosbys Creek, Cocke County, Tennessee, U. S. A.

Mass of 12.750 grams.—One polished face, showing great variation in structure. Portions of the surface show regular and well-marked Widmanstätten figures, while other parts show only irregular polygonal masses with no appearance of crystalline structure. Moreover, bright nickeliferous iron appears abundantly in some places, while other portions of the surface are entirely free from it. The exterior shows a very octahedral structure, and the plates are separated by a thick foil of schreibersite, which can be easily detached from the iron. (Smith collection.)

Mass of 451 grams.—One polished face showing characteristic Widmanstätten figures with sections of bright nickel-iron. The exterior shows very striking octahedral structure, and several of the octahedral faces have been polished and etched, showing no figures. Contains a very large nodule of troilite. (Smith collection.)

Sevier County, found in 1845, but evidently identical with Cocke County.

Mass of 7.710 grams.—Mass with two cut faces, one face containing a large nodule of graphite. The exterior shows beautiful octahedral structure. (Smith collection.)

Mass of 70 grams.—Nodule of graphite, formerly weighed 80 grams, but has been cut. Also numerous other nodules of graphite and troilite. (Smith collection.)

Mass of 711 grams.—Complete individual, containing a large nodule of graphite and showing all the characteristics structure of the Cocke County iron. This specimen was presented to the cabinet by Prof. N. S. Shaler and is reported to have come from Lebanon County, Tenn., but is evidently the same as the Sevier and Cocke County irons.

Fletcher [18] described crystals of graphitic carbon, cubo-octahedral in form, visible in some of the crevices of a large graphitic nodule from the meteorite.

Meunier [19] grouped the meteorite as arvaite. He states:

The schreibersite which abounds is in the form of an irregular network and the metal gives very imperfect Widmannstätten figures. There is considerable carbon, and Fletcher has noted cliftonite.

Huntington [20] regarded a number of the Tennessee meteorites as belonging to the Cosby Creek find. He also described an octahedron found in graphite from the Cosby Creek iron as follows:

While examining a nodule of graphite formerly obtained by J. Lawrence Smith from the Sevier County iron, it was accidentally broken and showed in its interior what appeared to be a skeleton octahedron of graphite three-eighths of an inch in diameter, and with all but one of its faces sufficiently perfect for measurement by an application goniometer. This striking feature at once suggests that this also may be a pseudomorph after diamond.

Cohen [21] found that the meteorite acted like soft iron in not acquiring permanent magnetism.

The distribution of the meteorite recorded by Wülfing [22] is 98,637 grams. The British Museum has 52+ kg.; Harvard, 21+ kg.; Tübingen, 12+ kg.; and numerous other collections the remainder.

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COSINA.

Loma de la Cosina or Cerro Cosina, near Dolores Hidalgo, State of Guanajuato, Mexico.
Latitude 21° 7′ N., longitude 100° 34′ W.
Stone. Crystalline chondrite (Ck) of Brezina; Sigénite (type 24) of Meunier.
Fell 11 a. m., January, 1844; mentioned, 1866.
Weight, 1.2 kgs. (2.6 lbs.).

Brief mention of this meteorite was made by Burkart [2] as follows:

This stone fell some time in January, 1844, at about 11 o'clock in the forenoon. The fall of the stone and the preceding flash of light were observed. The entire stone had an oval form and a distinctly crystalline structure. Specific gravity (Krantz), 3.095.

Buchner [3] gave the following account:

Herr Dr. Krantz, in Bonn, has kindly sent me for publication the following notice: "From Professor Castillo, in Mexico, Gehimrath Burkart and I received about a year ago half of a meteorite, hitherto unmentioned, with the following notice: In January, 1844, about 11 a. m. (date not given), a strange sound aroused the attention of laborers on the hill of Cosina about 8 leagues east of Dolores Hidalgo. At the same time they saw an illuminated body proceeding in a straight line and leaving behind a trail of light. The light as well as the trail was white and weak. As the sound ceased a cloud of dust arose and the laborers ran to see what had fallen. They found a hole 2 feet deep out of which they raised the meteorite.

"The stone has an oval form somewhat compressed in the middle. It has some similarity to the meteorite of Bremervorde. It is distinguished, however, from all hitherto known meteorites by its remarkable crystalline structure. The whole mass consists of crystals, the form of which is not discernible. Under a lens they show adamantine luster and may be anorthite. Iron is sparsely present. The specific gravity I found to be 3.095." The remark that the meteorite is like that of Bremervorde is peculiar, since while this consists almost wholly of crystals Bremervorde is not crystalline.

Meunier [4] classifies the meteorite as sigenite, and Brezina [5] as crystalline chondrite. Castillo [6] gives a more extended account of the meteorite than other writers, but his statements are meager enough. He says:

Meteorite de Loma de la Cosina—it fell upon the hill of this name 35 km. east of the village of Dolores Hidalgo on a clear day in the month of January, 1844, at 11 a. m., in the presence of laborers who raised it by means of a goad from a hole 2 feet deep in which it had buried itself. It was of an amygdaloidal form and was broken in two pieces, having a total weight of 1.2 kg. The meteorite is composed of mixed feldspar and meteoric iron and is surrounded by a dark crust of the same iron. The smaller fragment was presented and sent by me to Mr. Burkart, in Bonn, who gave one part to the British Museum (Natural History) and another to the Vienna Natural History Museum.

The above seems to complete the known history of the meteorite. The whereabouts of only 284 grams are traced by Wülfing,[7] although he states that according to Rath a fragment is in the collection of the School of Mines in Mexico and that Castillo perhaps possessed a piece.

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COSTILLA.

North side of Costilla Peak, Sangre de Cristo Range, Taos County, New Mexico.
Latitude 36° 55′ N., longitude 105° 30′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1881; described 1895.
Weight, 35 kgs. (78 lbs.).

This meteorite was described by Hills [1] as follows:

This meteorite, which for several years has been in the possession of the society, was found in August, 1881, on the north slope of Costilla Peak, about 6 miles south of the boundary line between Colorado and New Mexico. The date of the fall is unknown. The discoverer was a Mexican sheep herder named Ignacio Martin, who the same year sold the specimen to an old settler, one Thomas Tobeus, receiving in exchange a small pony. Tobeus kept the specimen for several years concealed under a manure pile in his barn, until Mr. E. C. van Diest, hearing of its existence and recognizing its true character, purchased it for the society. According to Mr. van Diest, to whom the writer is indebted for these particulars, it is impossible to obtain more specific information in regard to locality and occurrence, for the reason that Martin and his associates entertain the belief that the mass is native silver derived from a rich lode somewhere in the vicinity of the find, and they are naturally desirous of discovering and locating the bonanza themselves. Previous to slicing, the dimensions of the mass were: Length 32 cm., breadth 23 cm., thickness near center 10 cm. The weight on platform scales was approximately 78 pounds. When viewed in the direction of the shortest diameter, the outline is roughly rectangular. Of the two principal faces, one is rounded and comparatively smooth; the other, if anything, slightly concave with deep flutings and cavernous depressions. Two of the adjacent edges are comparatively thin and beveled. Of the other two, the longer exhibits a series of deep grooves, rudely parallel with the short diameter of the mass, though preceptibly divergent; the shorter has a smooth, facet-like termination. The well-preserved surface shows the fine striæ usually ascribed to the flow of the metal while passing through the atmosphere.

The etched surface shows the crystalline structure, which is approximately parallel with the direction of the octahedral cleavage. The kamacite bands are from 1 to 2 mm. in width and of considerable length. The tænite lines, which are irregular in trend and direction, are of capillary size and only visible through a lens or in strong reflected light. Here and there are small nodules of troilite, from 1 to 10 mm. in diameter, some of which inclose a dark-gray substance resembling graphite. The etched surface is traversed by prominent irregular cracks, roughly following the planes of cleavage, some of which inclose a black substance resembling graphite.

Analysis by Mr. L. G. Eakins:

Fe	Ni	Co	P	S	
91.65	7.71	0.44	0.10	0.26	=100.16

Mr. Eakins says: "The sulphur of course indicates the presence of troilite, which was plainly visible in the piece sent to me, and would be equivalent to one-half of 1 per cent of this substance. The phosphorus is derived from the schreibersite which was evidently present, being noticeable as the iron was being dissolved."

As the sample contained one of the larger nodules the troilite is probably less than is estimated by the analyst.

Brezina [2] says of Costilla:

Costilla Peak shows, on a plate cut through the whole mass, beautiful orientation of the surface; the convex edge face, plainly belonging to the front side, shows traces of the somewhat rusted, thin front crust along which runs a glimmering alteration zone 2 to 5 mm. thick. The concave opposite side shows a rear side crust 0.5 to 2 mm. thick, at the thicker points concentrically layered, and an alteration zone 1 to 9 mm. thick. The lamellæ are long, straight, grouped, 0.8 mm. thick, the tænite weak, fields predominant, mostly containing repetitions of the lamellæ. The kamacite and fields are granular; the former coarse, the latter fine. There are many troilite grains and plates distributed through the whole mass. Great similarity with Independence.

The meteorite is distributed.

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Couch Iron, see Fort Duncan.

CRAB ORCHARD.

Crab Orchard Mountains, Cumberland County, Tennessee.
Here also Powder Mill Creek and Rockwood.
Latitude 35° 50′ N., longitude 84° 47′ W.
Iron-stone. Grahamite of Brezina; Logronite (type 31) of Meunier.
Found 1887; described 1887.
Weight: At least five masses weighing 85, 9, 5.75, and 3.5 pounds; total about 50 kgs. (107 lbs.).

The first account of this meteorite seems to have been given by Howell [1] as follows:

About the middle of March, 1887, Mr. Elihu Humbree found, on land owned by Mr. W. B. Lenoir, 8.5 miles west of Rockwood Furnace, Cumberland County, Tennessee, several pieces of what has proved to be a meteorite of very great interest, belonging to the rare class of siderolites, resembling in general appearance the Atacama, but differing very widely in the nature of the silicate. Mr. Humbree, mistaking the bright specks of nickeliferous iron for silver, detached several large pieces and many small fragments in the attempt to find a lump of native silver.

Three or four weeks later, Mr. Lenoir, suspecting the nature of the find, secured the whole of it with the exception of some small pieces which had been given to friends. Several weeks later the entire mass was secured by Ward and Howell.

The main mass is an irregular ellipsoid, with one side a little flattened and noticeable on account of the almost entire absence of the usual pittings which are present elsewhere on the surface. It measures 14¾ by 10 by 8½ inches. The weight, which, owing to the loss of some of the fragments can not be determined accurately, is 83 pounds. Three other smaller masses bring the weight of the entire find to fully 100 pounds (probably 203 pounds more), of which 96.5 pounds have been received.

The analyses thus far made show it to be in the main a silicate of alumina, lime, magnesia, and ferrous oxide, probably in the form of anorthite and augite, with no olivine. The iron grains contain 12 per cent of nickel, a trace of copper, and seem to be distributed quite evenly through the mass. One nodule of iron, however, measures three-quarters of an inch in diameter and shows the Widmannstätten figures very characteristically on the etched surface. Although the analysis shows an unusually large percentage of nickel present, decomposition has only affected the surface and the seams, and to so slight a degree that the original black crust still remains over a considerable portion of the surface.

As to the length of time it has lain exposed since its fall, nothing is definitely known. In the late autumn of 1880, however, between 5 and 6 o'clock in the afternoon, a meteor was seen passing to the northwest over Morgan County, Georgia, which left a dense trail, not very wide, of light-colored smoke, which could be seen for at least half an hour, and which gradually spread out thin and wooly like ordinary smoke. A loud report, thought to be about 3 minutes after the passage of the meteor, was heard by persons who did not see it, as well as by those who did. This meteor may be the one from which we have this meteorite.

A more detailed study was given by Whitfield [2] in November of the same year as follows:

The Rockwood meteorite was found about the middle of March, 1887, by Mr. Elihu Humbree on a range of the Crab Orchard Mountains. The field in which it was picked up is now owned by Mr. W. B. Lenoir, and is situated 8.5 miles west from Rockwood, Tennessee, in Cumberland County. The material for analysis was received from Messrs. Ward and Howell, of Rochester, New York, the present owners of the meteorite, to whom we are indebted for the privilege of description.

There were three pieces found, the smallest measuring 4 by 3 by 2.5 inches and weighing 3 pounds 10.5 ounces; the next larger measuring 7⅞ by 6½ by 2⅝ inches and weighing 5 pounds 13.5 ounces; and the largest, an irregular egg-shaped mass a little flattened on one side, measuring 14¾ by 10 by 8½ inches, with a weight of about 85 pounds, and a specific gravity of 4.240.

The mass is quite brittle, very hard to saw, but easily broken by hammering. Cut slices show many irregularly shaped stony fragments with some nodules, the largest seen being about ⅝ by ⅜ inches on the surface diameter. In the larger slices the stony part is so broken as to give the polished surface a brecciated appearance. In analysis, the metallic portion was freed from the mineral part by crushing to rather fine particles and separating by the aid of a magnet. This was again treated in the same manner, and the resulting metal washed with alcohol and quickly dried; by this method it was found possible to free the metal from all but the merest trace of stony substance.

The metallic portion proved to be an alloy, rich in nickel, as is shown by the following figures:

Fe	87.59
Ni	12.09
Co	Trace.
Cu	Trace.
P	None.
S	None.
	99.68

The metallic grains seem to be quite evenly distributed through the mass. In but one instance does a nodule appear to have attained a size larger than that of a pea, and on the section of this nodule we were able to obtain the Widmannstätten figures by etching.

The rocky part, after being freed as well as possible from metal, was finally ground and digested with dilute hydrochloric acid, and the resulting soluble and insoluble portions investigated separately, but from the fact of there being a number of minerals mixed together, no satisfactory conclusion could be drawn from the examination. The mass was therefore analyzed as a whole with the following result:

SiO_2	41.92
Al_2O_3	9.27
FeO	22.94
CaO	9.09
MgO	8.76
Fe	3.75
Ni	1.74
Cl	0.18=0.32 $FeCl_2$
P	0.65
S	1.58
	99.88

By the analysis of the portions soluble and insoluble in dilute acid, it was found that the greater part of the lime and but a trace of the magnesia had gone into solution, proving the absence of olivine, and giving grounds for the supposition that the rocky portion is mainly a mixture of anorthite and a silicate related to augite, but very rich in iron.

It will be noticed that the ratio between iron and nickel in the metallic portion is greater than that in the rock. This is accounted for by the fact that in the rocky part of the meteorite, the iron, as metal, has been greatly oxidized, as is shown by the large amount of rust covering the specimens, caused no doubt by the chloride of iron present, and is reckoned as FeO, accounting for the large proportion of iron in the supposed augite.

Owing to the bad condition of the fragments subjected to analysis, we have no grounds on which to compute the phosphorus and sulphur as schreibersite and troilite, but from the fact of these minerals being among the more common constituents of this class of meteorites, and also that in the main analysis of the rock portion phosphorus and sulphur were found, it is probable that the phosphide and sulphide of iron are two of the minerals present.

One of the polished slices contained a nodule of about half an inch in diameter, which was sacrificed in order that its nature might be determined, and the following figures give the results of analysis. The mineral was finely ground, the metallic portion, if any, separated by aid of the magnet and digested in dilute hydrochloric acid.

The insoluble portion was found to be 94 per cent, the composition of which is—

SiO_2	51.85
Al_2O_3	4.52
FeO	13.26
CaO	1.09
MgO	29.28
	100.00

Giving the ratio of R″O to SiO_2 93:86, which corresponds well with the mineral enstatite, although in this case much of magnesia is replaced by iron. The soluble portion consisted of iron with a slight trace of nickel, which tends to show that the nodule contained some metallic particles which it was impossible to extract with the magnet. During the digestion in acid, as no sulphuretted hydrogen could be detected, we infer the nonexistence of sulphides in the nodule.

The total mineral was also analyzed with the following results:

SiO_2	49.96
Al_2O_3	4.75
FeO	15.97
CoO+NiO	Trace.
CaO	1.15
MgO	28.15
	99.98

This meteorite is a lithosiderite poor in metal, the metallic portion not exceeding 16 per cent of the mass. The stony part is probably anorthite and enstatite.

Kunz[3] gave the following account of the meteorite:

Through the kindness of Mr. Moritz Fischer, of the Kentucky Geological Survey, I am now the possessor of a piece, weighing over 2,000 grams, of the meteorite which Colonel Sublet and Mr. Lenoir found on the farm of Elihu Humber, at Powder Mill Creek, about 8 miles west of Rockwood Furnace on the eastern slope of Crab Orchard Mountain, latitude 35° 50′ N., longitude 84° 45′ W., in Cumberland County, Tennessee (Rockwood being in Roane County).

It resembles very closely the Hainholz, Westphalia, 1856, and the Newton County, Arkansas, irons, now the Taney County, Missouri. It is scarcely distinguishable from the latter except that in the latter the grains are larger and more readily defined. The specific gravity was found to be 4.745. Chloride of iron (lawrencite) is present in considerable quantities and on a number of sections which had been cut and polished it was perceptible within a short time. It collected in small beads on the piece itself which will undoubtedly lead to a rapid disintegration unless the iron is coated with varnish or some other preservative. Even small fragments have already become seamed, suggesting that the fall is recent.

Microscopic sections were prepared and in the groundmass of metallic iron were seen clear crystals of anorthite and olivine. The former are transparent, with inclusions of glass having fixed gas bubbles and of many needle-shaped microlites and some of larger size. The former microlites are probably enstatite, while some black quadratic sections may be chromite or magnetite. The twinning bands of the anorthite are sharp and distinct. The olivine crystals have greenish, brownish veins of alteration (perhaps induced by the lawrencite) with inclusions of glass, microlites, and an abundance of black grains of picotite. These grains are occasionally arranged symmetrically around the crystals as a border, outside of which is usually a grayish, partly opaque mass between the crystal and the metallic iron. This grayish mass is an alteration of the olivine which in many cases has taken place in the entire crystal and in others leaving only a small center of clear olivine. To Mr. J. H. Caswell the writer is indebted for the above microscopical data.

In a footnote to this article Kunz states that this meteorite is identical with the Rockwood meteorite and that he gives the name Powder Mill Creek to it because it fell in Cumberland County, Roane County in which Rockwood is situated being adjacent to this.

Newton[4] states that the nickel-iron in this mass consists of isolated particles arranged in most instances in a system of lines which resembles that of the Widmannstätten figures, as may be seen by holding a polished section in a strong light at some distance from the observer. Cohen[5] found a substance resembling tridymite (asmanite) which, however, he could not investigate more fully at the time. According to Cohen also, Daubrée found an abundant exudation of iron chloride in the meteorite. Cohen also remarks that the meteorite appears to be free from olivine and is thereby distinguished from grahamite.

Brezina[7] makes the following observations:

The iron here plays the part of a "filler" between the silicate masses. Dark, angular silicate fragments as much as 4 cm. in size, lie embedded in a matrix of bright gray, crystalline silicate particles and intermingled, mostly fine, iron particles, so that dark and bright gray fragments are apparently of the same sort; sometimes the same fragments are half bright, half dark. The larger silicate fragments are sometimes intermixed with iron specks and also longer iron streaks. Altered, red-brown olivine crystals attain the size of hazelnuts.

The meteorite is distributed among collections, about one-third being in the collection of the Field Museum. The latter collection possesses one complete individual weighing 4,315 grams which is not mentioned in the published accounts.

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Cranberry Plains. See Poplarhill.

Crawford County. See Mincy.

CROSS ROADS.

Boyett, Cross Roads Township, Wilson County, North Carolina.
Latitude 35° 40′ N., longitude 78° 5′ W.
Stone. Gray chondrite (Cg) of Brezina; Chantonnite (type 42) of Meunier.
Fell 5 a. m., May 24, 1892; described 1893.
Weight, 161 grams (5 ozs.).

Howell [1] describes this as

a small aerolite which fell about 5 o'clock in the morning on May 24, 1892, in the township of Cross Roads, Wilson County, North Carolina. It was seen by a young man named Gray Bass, who was only about 200 feet distant. He seems to have been frightened by the sight and sound and waited two or three hours before going to the spot. He dug it up from the ground where it had embedded itself about 4 or 5 inches in compact sodded earth close by a roadbed. The finder states that the grass near the spot was dead and looked as if it had been killed by fire. He thought it came from the northwest. It was, however, heard by others as far as 18 miles in the opposite direction, i. e., southeast. Among those who heard it was a colored boy a quarter of a mile to the southeast, and Micajah Hales 4 to 6 miles to the southeast, who describes the noise as "somewhat like thunder accompanied by lesser sounds like the report of pistols or the snapping of burning reeds." Another man, Edward S. Dees, distant 5 or 6 miles nearly south, who was in an open field some time before sunrise, heard a peculiar noise which lasted a quarter of a minute and sounded like "a freight train crossing a trellis," and thought that the noise came from the southwest. William B. Scott, about 18 miles to the southeast, says that before sunrise on May 24 he and a neighbor heard a noise "something like a skyrocket but more like thunder, which went off in a northern direction."

The stone now weighs 157 grams and would probably have weighed 200 grams if it had reached the earth unbroken. The thick even crust indicates that it was a complete individual and not one of a shower. The fresh fractured surface is of the usual gray color and the structure is chondritic. The stone measures 1 by 2 by 2.5 inches.

Specific gravity, 3.67. This is somewhat greater than most meteorites of this class, indicating a little more iron.

The stone is distributed.

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Crow Creek. See Silver Crown.

CUBA.

Eastern portion of the Island of Cuba, West Indies.
Latitude 21° N., longitude 77° W, approximately.
Medium octahedrite (Om), of Brezina.
Described 1872.
Weight: Madrid mass, 1,329 grams (3 lbs.).

Little is known of this meteorite except the description given by Solano y Eulate [1] in 1872. A translation of his account follows:

Coming from the eastern department of the island of Cuba, there is in the cabinet of natural history in Madrid, without other details concerning its origin, an example of meteoric iron, weighing 1,327 grams, which, belonging to Spanish territory and no aërolite of that colony having been hitherto described, I consider it worth while to describe. The considerable number of meteoric irons found in the United States which is at so short a distance from the above-mentioned island, makes it easy to understand the discovery there of a meteorite of this species, there being sufficient motives to suspect the existence of others even though not discovered.

The specimen which forms the subject of this sketch is an incomplete aërolite, as appears to be indicated by the fragmentary aspect of one part of its surface. It presents the form of a segment of a ring raised and uneven in the narrowest part, rounded and attenuated in the widest, resulting that its transverse section is approximately triangular. The surface of its upper and lower faces is undulating, as is that of all meteoric irons and stones, and recalls, although roughly, the impressions which the fingers leave upon a pasty substance. The circumstance that the other surfaces lack this characteristic proves that the specimen is only part of an aërolite which must have broken after the cooling of its external coat. This constitutes a most delicate crust of iron rust, arising probably from the oxidizing action of the atmosphere.

Its structure is granular, presenting numerous irregular pittings unevenly distributed in the mass, due perhaps to the fusion of the troilite. The luster of the natural surface is lively and is notably increased by polishing. Its hardness is extraordinary. It scratches glass and may be represented by 6.9; that is, very little below that of quartz—a noteworthy circumstance.

This explains the failure of various attempts to cut off a layer of it, although it was taken for this purpose to the arsenal, where all attempts proved futile, and only succeeded after spoiling several files, in making a dent of a very few millimeters in depth in its surface.

The tenacity of the Cuba iron preserves a relation to its hardness. It gives sparks with steel, a property not common among aërolites of this kind, and only after repeated and strenuous exertions was it possible to break off small fragments with a heavy hammer on an anvil. The exterior rust crust does not have this property, but is breakable and even fragile.

Likewise, the fragments appear to have been some time separated and oxidation to have penetrated from the exterior to the interior on account of the spongy structure. The fragments show malleability under a hammer, and can be powdered only with difficulty. The density found is between that of Claiborne, determined by Rumler as 6.82 and that of Rokitzan, Bohemia, which was found to be 6.005. That of our meteorite is 6.44. As would be expected of a mass composed exclusively of iron, this meteorite is strongly magnetic without distinction of poles. Polished with emery to a smooth surface and submitted to the action of nitric acid for some minutes the Widmannstätten figures are produced like those of Charcas, with nodular forms of schreibersite. Submitted to the action of aqua regia for some days it largely dissolved, forming a reddish liquid and a black residue. The solution tested, according to the method of Will, showed only iron and nickel. The insoluble portion deflagrated with niter and carbonates of soda and potash, and treated with boiling water, gave, with ammonium molybdate, a greenish yellow precipitate, showing the presence of phosphorus in considerable quantity. The soluble portion treated with hydrochloric acid and an analysis by the system of Will gave iron and nickel. A portion of the meteorite deflagrated with niter and potash and treated with water gave, with barium chloride, an abundant white precipitate insoluble in acids, which is barium sulphate and which shows the presence of sulphur. The green coloration produced before deflagration shows manganese as does also the violet tint produced by the nitric acid solution of the meteorite in the presence of lead oxide. Submitted to the action of aqua regia for a week 0.4897 grams gave a residue of 0.274 grams, showing the following composition:

Soluble portion	94.41
Insoluble	5.59
	100.00

Separating in the soluble portion the iron and nickel by addition of ammonia in excess in presence of sal ammoniac, the following result was obtained:

Iron	96.76
Nickel	3.24
	100.00

From the preceding it appears that this meteorite is composed of a mass of nickeliferous iron with double phosphide of iron and nickel (schreibersite), and probably some troilite.

The specimen seems to be almost wholly preserved in Madrid.

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CUERNAVACA.

State of Morelos, Mexico.
Latitude 18° 56′ N., longitude 99° 10′ W. (Ward).
Iron. Fine octahedrite (Of), of Brezina.
Mentioned, 1889.
Weight about 35 kgs. (77 lbs.).

Cuernavaca is first mentioned by Castillo [1] who states that in the National Museum in Mexico is a fragment of an iron meteorite which was found on the way from Mexico to Cuernavaca. Fletcher [2] repeats Castillo's statement and adds that Cuernavaca is 50 miles from Xiquipilco and 40 miles from the city of Mexico. He thinks, therefore, that Cuernavaca was from the Toluca valley. Brezina [3] and Berwerth simply repeat the opinion of Fletcher. As a matter of fact, Toluca and Cuernavaca are irons of very different character. The first detailed description was given by Ward [4] as follows:

The mass was entire, never having had any further than a minute chisel chipping, the common way of Mexican prospectors, who test all troven metal masses in their search for silver. The length of the mass was 480 mm. (about

19 inches), while its other diameters were about 130 mm. to 150 mm. (about 5 to 6 inches), varying in different parts of the mass. The form might be described as a square-sided, irregular column, with some protuberances and constrictions; and one of its extremities, much enlarged, projected several inches forward of the main line of the mass in a sort of a subcylindrical turban. The surface of the mass, though very uneven with alternate elevations and depressions short and sharp in contour, is still smooth in texture and is quite covered with a reddish-brown crust which is of unusual thickness and continuity. This surface over the entire mass is impressed with indentations from 0.5 to 1.5 inches long, like chisel marks. The section of the iron shows these indented lines to correspond with numerous straight, short seams of troilite, which cross the mass in all parts and at all angles. There are also several small troilite nodules, with one of 30 mm. in diameter. These nodules are surrounded and crossed by a narrow border of schreibersite. Etching brings out well-marked Widmannstätten figures of the octahedral type. In these the kamacite blades vary greatly both in breadth and length, causing a coarser or finer pattern in different parts of the section. The plessite patches are seen to be composed of alternate layers of kamacite and tænite. The latter, although in fine films between the kamacite blades, show prominently from their brightness. Specific gravity, 7.725.

Analysis (Whitfield):

Fe	88.98
Ni	10.30
	99.28

The characters of the etched surface of this iron show much similarity to those of the Bella Roca siderite.

Cohen [5] gave a description and analysis which led him to the conclusion that Cuernavaca was a distinct fall. Later [6] he described the structure more fully, as follows:

The lamellæ are rarely long, generally short, swollen and irregularly bounded, generally not grouped but at times weakly so, the tænite border broad and very sharp; the fields abundant though not equal in quantity to the bands. The kamacite is darker than the plessite. It consists in part of sharply bounded, irregularly shaped grains for the most part characteristically striated so as to show lines under the microscope. In the neighborhood of the natural surface these seem to be more abundant and plain than in the interior of the meteorite, although usually an opposite relation occurs. Most of the fields consist of fine-grained plessite which is so rich and uniformly distributed in shining flakes that it, except for a fine border, appears considerably brighter than the kamacite. The grains are so grouped that it appears on stronger magnification as if isolated black grains lay in a bright, shining groundmass. In a second, smaller group of fields the grains extend like striæ so that a nearly octahedral structure is produced though without sharp separation of light and dark striæ. In many fields entire lamellæ or abundant combs appear until the whole field is filled with the latter. The small bands are like the large ones, in part striated, in part granular. Schreibersite is sparingly visible, but analysis shows that it must be quite abundant in small particles. No other accessory constituents were observed.

Analysis (Hildebrand):

Fe	Ni	Co	P	S	Cr	Cu	
89.70	8.76	1.19	0.33	0.12	0.00	0.05	=100.15

Mineralogical composition:

Nickel-iron	97.58
Schreibersite	2.09
Troilite	0.33
	100.00

Specific gravity, 7.748.

The mass is chiefly preserved in the National Museum of Mexico.

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Cumberland County. See Crab Orchard.

CYNTHIANA.

Harrison County, Kentucky.
Latitude 38° 23′ N., longitude 84° 17′ W.
Stone. Gray chondrite (Cg) of Brezina; Parnallite (type 44) of Meunier.
Fell 4 p. m., January 23, 1877.
Weight, 6 kgs. (13.2 lbs).

This meteorite was first described by Smith [3] as follows:

I have called this the Cynthiana stone, although it fell 9 miles from that place in Harrison County, Cynthiana being the nearest important point to the place where it fell.

At about 4 p. m. on January 23, 1877, a brilliant meteor was seen traversing Monroe County, Indiana, in a southeast direction at about 35° above the horizon; it was also seen by several persons in Decatur County of the same State, latitude 39° 27′ N, longitude 85° 28′ W., where it disappeared just as it seemed to touch the earth not more than a quarter of a mile distant. It really fell about 60 miles away. Apparently it was not seen in the State of Ohio, but in the State of Kentucky it was observed over a considerable area. The phenomenon culminated in the usual noises heard in the heavens. Fortunately one observer, an intelligent farmer, heard a solid body strike the ground; he walked immediately to the spot and dug the stone out of the ground from a depth of 13 inches.

The stone weighs 6 kg.; it is wedge shaped, with one portion very extensively and regularly pitted, while the rest is comparatively smooth. The crust is dull black and is as perfect as when the stone fell. There was a fresh broken spot of 2 or 3 sq. cm. which was evidently made prior to the fall, for a few small specks of melted matter adhered to the surface. In texture the meteorite belongs to the harder brecciated variety, and when broken presents a mottled surface identical with that of the Parnallee stone, which it resembles in every other particular. The specific gravity of the two meteorites is identical, viz, 3.41.

The stony material freed from metallic iron consisted of—

Matter soluble in HCl	56.50
Matter insoluble in HCl	43.50
	100.00

Some of the soluble part was composed of troilite which I could not separate mechanically; it is deducted in the following analysis:

	SiO_2	FeO	Al_2O_3	CaO	MgO	
Soluble part:	33.65	30.83	0.11	trace	34.61	=99.20

	SiO_2	FeO	Al_2O_3	CaO	MgO	CrO	Na_2O	
Insoluble part:	57.60	11.42	0.43	5.70	23.97	0.38	1.24	=100.74

The nickel iron (5.93 per cent of the whole) contains:

Fe	Ni	Co	
90.64	8.35	0.73	=99.72

The minerals in this stone are quite easily distinguished by the eye but are very much more conspicuous under a moderate magnifying power, especially the round and distinct concretions of a light-yellow bronzite. The troilite and metallic specks and filaments are also easily seen.

No attempt was made to separate the stony minerals in sufficient quantity for analysis; quantitative tests were made to distinguish their character. From the chemical examination previously made I deduce the following as about the proportion of the mineral constituents:

Olivine minerals	50.00
Bronzite and pyroxene minerals	38.00
Nickel iron	6.00
Troilite	5.50
Chrome iron	0.52
	100.02

There were no distinct crystals of minerals visible either to the unaided eye or with a lens.

Little or nothing of importance has been added to Smith's account of this meteorite. It is somewhat distributed, Harvard possessing 4,093 grams. This is largely a single stone (3,113 grams), evidently possessing orientation as shown by Huntington's [6] description, as follows:

Dull gray, with white grains and some iron. This specimen shows a distinct front, consisting of a nearly flat surface covered with a dull-black crust full of small, round pittings. The crust has flowed back in deep furrows piling up into a point behind. Quite a large piece has been broken from one edge of the specimen.

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Dacotah, see Ponca Creek.

Dakota, see Ponca Creek.

DALTON.

Whitfield County, Georgia.
Latitude 35° N., longitude 84° 54′ W.
Iron. Medium octahedrite (Om) of Brezina; Caillite (type 18) of Meunier.
Found 1860; described 1886.
Weight: Two masses, weighing 53 and 6 kgs. (117 and 13 lbs.).

The first mention of the masses known as Dalton seems to have been by Smith [1] who simply stated that he had received a meteorite from Dalton, Whitfield County, Georgia, which he would shortly describe. In 1880 Brezina [2] described a fragment under the name of Dalton as follows:

A fragment in the Vienna Museum showed moderately wide Widmannstätten figures, which in a few places, on account of the abundant occurrence of schreibersite, become irregular; the tænite is tolerably broad, the plessite, on account of its unusually dark color and the complete absence of ridges, is inconspicuous; in many places veins filled with magnetite pass from the natural surfaces 2 or 3 cm. deep into the interior of the iron.

A 13-pound mass from the locality was described by Hidden [3] as follows:

This iron was discovered in 1877 on a farm about 20 miles northeast of Dalton, Georgia, near the Tennessee and North Carolina State line, a region remarkable for the number of meteorites it has afforded. As has happened in similar cases the specimen was locally considered to be native iron and was preserved as such until Dr. Geo. B. Little, then State geologist of Georgia, visited the region in 1878 and recognizing its real nature procured it for the State museum at Atlanta.

In its complete condition this meteorite is said to have weighed 13 pounds. Its present weight is 9.75 pounds. Doctor Little states that one end became detached on the way to Atlanta. The mass remaining is thin and oblong in shape and much resembles a very rusty mass of ordinary iron. It is about 10 inches long and 5 inches wide and varies in thickness from 1 to 1.5 inches. Its surface is very irregular and has many jagged points. It is of the usual composition, with deliquescence of chloride of iron in many spots. The Widmannstätten figures are remarkably well developed on this iron.

Two years later, Shepard [4] described a mass weighing 117 pounds as follows:

Whether the mass here described is of identical origin with that found in 1877, and described by W. Earl Hidden in volume 21, No. 124, p. 287, of the American Journal of Science, is not quite certain.

The circumstances of the finding of this meteorite are detailed in a letter of H. C. Hamilton, of Dalton, Georgia, to Maj. E. Willis, of Charleston, South Carolina, under date of October 18, 1882.

The meteorite was found some time in the year 1879 by Francis M. Anderson on his farm, on lot No. 109 in the 10th district and 3d section of Whitfield County, Georgia, about 14 miles northeast of Dalton. It was discovered while plowing on the west side of a ridge, near its base. The ridge runs north and south, and the furrows east and west. It was lying with its apex upward, and buried about 6 inches below the surface of the ground.

Some time during the fall of 1860, an unusual atmospheric phenomenon occurred in the region. A bright light shot across the heavens, followed by a loud report, creating great alarm among the people, many of whom supposed the end of the world had arrived.

A large mass of iron, supposed to be a meteorite, was found half a mile from this one about the year 1862. It was sent to Cleveland, Tennessee, where it appears to have been lost sight of.

The mass now described belongs to the meteoric collection of C. U. Shepard, jr., of Charleston, South Carolina. It weighs 117 pounds.

Its shape is somewhat that of a pear whose apex is slightly trihedral. The surface is nearly black and very little oxidized. It is destitute of deep indentations, and presents a surface with only faint, wavelike depressions.

It is more easily divided with the saw than most irons, owing to the absence of pyritic veins and kernels. When broken across a thickness of one-eighth of an inch, it presents a coarse, but highly uniform, granular structure, and

shows a cleavage of the individuals, much resembling that of the Braunau iron. Its polished surfaces are almost perfectly homogenous, being wholly free from amygdaloidal inclosures. At places within an inch of the outside, however, a few very thin, black, thread-like veins occur, apparently the products of shrinkage in the process of cooling. The substance of these veins is partly the oxides of iron with which is intermingled a trace of chlorine, the latter probably derived by infiltration from the soil. The deliquescence of the polished surfaces is confined to these black seams.

The Widmannstätten figures present a rather remarkable feature. The peculiarity of the pattern consists in the tendency in one series of bars to cross each other at right angles, while in a second series, less uniform in width, they pass diagonally (in descending) from right to left across the shaded spaces.

On etched surfaces, the schreibersite shows in exceedingly thin and nearly straight continuous lines, though they are occasionally interrupted at short intervals, when they resemble the markings on telegraphic ribbons. The continuous lines sometimes swell into triangular or polygonal enlargements, forming a string of nearly disconnected beads.

The analysis of C. U. Shepard, jr., gave:

Fe	Ni	Co	
94.66	4.80	0.34	=99.80

Specific gravity, 7.986.

It is not possible to decide whether this meteorite belongs to the same fall with the 13 pound mass described by Mr. Hidden. The two were found at different times, several miles asunder, and were totally unlike in the character of their surfaces. Besides, the smaller abounded in chlorous deliquescence; and it appears to have been easily separated by cleavage, suggesting a longer contact with the soil.

Brezina [5] described the structure of a section from the large mass as follows:

A specimen in the Vienna museum shows the kamacite sometimes very finely hatched, sometimes entirely free from hatching, and even somewhat granular.

The next year Kunz [6] suggested that the Lea or East Tennessee meteorite might be from the same locality as the Dalton meteorite. Some of his arguments were as follows:

A large etched section of this iron—the Lea iron—shows several cracks completely filled with rust, indicating large quantities of chloride of iron in the mass. The large mass of the Whitfield County iron rusts, cracks, and exfoliates exactly like the above. The Widmannstätten figures are also identical.

Cleveland, Tennessee, is 28 miles northeast of Dalton, Georgia, and the Whitfield County iron was found 14 miles northeast of Dalton, the latter place being very near to the State line. Mr. Raht also states that a 50 pound (?) mass fell 10 miles from Cleveland, near the State line, which locates it very near where the Whitfield County iron was found. Cleveland, Tennessee, the place from which the East Tennessee meteorite is said to have been sent, is on or near a railroad line. The mass was probably sent there for sale or to be worked at one of the iron furnaces. When we consider that the war was then in progress, and that even for some years after the war intercourse which had been broken off was not resumed, it is not unreasonable to suppose that this mass may have lain unnoticed for several years.

A difference in the analyses of the two meteorites is mentioned by Kunz, but it is suggested that this is not an insuperable objection to uniting the two.

In spite of Kunz's suggestion the two meteorites have usually been listed separately.

In order to test the supposed difference in chemical composition a fragment from the Dalton specimen in the Field Museum collection was analyzed by H. W. Nichols. This analysis, which has not previously been published, gave:

Iron	91.02
Nickel and cobalt	7.38
	98.40

These values differ much less from the analysis of the Lea iron than do those obtained by Shepard. Shepard's values would be anomalous for a meteorite of this group. Another point of resemblance between the two meteorites is the presence of Reichenbach lamellæ, remarked by Cohen [7] independently for the two irons.

The large mass, 50,917 grams, of Dalton is mentioned in Clarke's catalogue as in the United States National Museum collection, but is not mentioned by Tassin. 1900.

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DANVILLE.

Near Danville, Morgan County, Alabama.
Latitude 34° 25′ N., longitude 87° 4′ W.
Stone. Gray chondrite, veined (Cga) of Brezina.
Fell 5 p. m., November 27, 1868; described 1870.
Weight, 2 kgs. (4.5 lbs.).

Knowledge of this meteorite is confined almost wholly to the account by Smith [1] which is as follows:

On Friday evening, November 27, 1868, about 5 o'clock, Mr. T. F. Freeman, of Danville, Alabama, on stepping from his house, was startled by a loud report so much like artillery that for the moment it was attributed to the firing of a small piece kept in the village; but on inquiry it was found that no firing had taken place there but that the sound was heard at the village, and attributed to very heavy artillery at Decatur, Trinity, Hillsboro, or some other point to the northward of Danville. * * *

The following day Mr. William Brown, living 3 miles west of Danville, brought to the village a piece of rock which he said fell near him and some laborers who were picking cotton. He dug it up at a depth of about 1.5 to 2 feet. It weighed about 4.5 pounds and had the characteristic aspects of a meteoric stone but it was broken by the party obtaining it and all but about half a pound, now in my possession, had been scattered and probably lost or thrown away.

Several other stones fell in the same vicinity. Some negroes working in a cotton field on the plantation of Capt. McDaniel, half a mile from Danville, heard a body fall with a whizzing, humming sound, and strike the ground near them with tremendous force but they were alarmed and did not approach the spot that night; a rain fell during the night and no trace of it could be found next day. Various other stones were heard to fall in different parts of the adjacent country. Two brothers by the name of Wallace were plowing in their field, about 1.75 miles northwest of Danville, they distinctly heard two or three fainter reports after the first loud one and heard the sound of two falling bodies whizzing down, one to the right and the other to left of them.

With the above data and the known geography of the country its direction must have been northeast and southwest, but it is impossible to say from which of these quarters it came.

The portion of the meteorite that I possess has a large part of it covered with the usual black crust. Its general aspect is rough and dull; a portion of the outer surface, not covered with the black coating, was nevertheless a surface which it had when it reached the ground for on this surface are streaks and little patches of bright, pitchy matter which was once fused, and was derived either from another part of the coating that was thrown off in a melted state from the coated portion, and whipped around as it were on to the unfused surface as the stone fell through the air, or from an incipient fusion that was begun on the denuded surface and arrested by the termination of the fall. Where the black crust reaches the denuded places it appears to be rounded off as if it had been melted matter passing from one portion of the stone and rolled over the surface of the borders.

The broken surface has a dark gray color and is somewhat oolitic in structure, but not as much so as many other meteoric stones. There are veins and patches of a slate-colored mineral running through it. Pyrites and iron are also to be seen diffused through the stone; thin flakes of the iron give that slickensided appearance to a fracture not unfrequently seen in this class of bodies. There seems to be more of iron in the slate-colored mineral than in other parts. There are a few patches of white mineral which may be enstatite. The specific gravity of the stone is 3.398.

For further examination a portion of the meteorite was mechanically separated into three parts, the pyrites, the metallic iron, and the earthy minerals. As in the case of most meteorites the earthy minerals were so intermixed that it was impossible to separate the different varieties, three of which were easily traceable by the eye.

The iron separated with great care from the pulverized meteorite constitutes 3.092 per cent of the entire mass, and an analysis furnished:

Fe	Ni	Co	Cu	P	S	
89.513	9.050	0.521	minute quantity	0.019	0.105	=99.208

The sulphide of iron detached very carefully from the mass of the meteorite gave:

Fe	61.11
S	39.56
	100.67

which corresponds with the prosulphid of iron, FeS. Whether it contains any troilite was not determined.

The stony minerals were freed as much as possible from iron and pyrites and reduced to—

Soluble portion	60.88
Insoluble portion	39.12
	100.00

The insoluble portion yielded upon analysis:

Silica	Alumina	FeO	MgO	Lime	
50.08	4.11	19.85	20.14	3.90	=98.08

From all the circumstances connected with this mineral, its physical characters, etc., it is doubtless a pyroxene of the augite variety.

The soluble portion, owing to the unavoidable presence of a little iron and pyrites, simply furnished results on analysis that showed it to be mostly olivine. The stony matter as a whole freed as much as possible from pyrites and nickeliferous iron, gave:

Silica	45.90
Protoxyd of iron	23.64
Magnesia	26.52
Alumina	1.73
Lime	2.31
Soda	0.51
Potash	0.64
Oxide of manganese	minute quantity, not estimated.
Oxide of chrome	minute quantity, not estimated.
Phosphorus	minute quantity, not estimated
Lithia	marked reaction with the spectroscope.
Sulphur	1.01
	102.26

The excess in the footing up of the analyses above 100 per cent is due to the fact that a part of the iron, estimated as protoxyd, is combined with sulphur forming sulphide of iron.

This meteoric stone is similar in every respect to that which fell March 28, 1859, in Harrison County, Indiana. This meteorite is therefore composed of nickeliferous iron, olivine, pyroxene, protosulphid of iron, with minute quantities of schreibersite, chrome iron, and probably albite.

Later catalogues mention Danville but give little or no account of it. Brezina[6] classifies it as veined gray chondrite.

But little of the meteorite is now preserved, the Harvard collection possessing the largest amount (105 grams).

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Davidson County, see Drake Creek.

DEAL.

Monmouth County, New Jersey.
Latitude 40° 17′ N., longitude 74° W.
Stone. Intermediate chondrite (Ci) of Brezina; Lucéite (type 37, subtype 2) of Meunier.
Fell 11.30 p. m., August 14, 1829; mentioned 1829.
Weight: Unknown. probably about half an ounce (14 grams).

The first mention of this stone seems to have been in 1829,[1] though the authorship does not seem to be known. This mention was as follows:

At Deal, New Jersey, on August 14, 1829, two aerolites fell with black, uniformly irregular surfaces, the interior bright gray with metallic points. A bright meteor preceded its fall, which occurred about midnight. The meteor first rose like a rocket, described a curve, and then exploded. There were some 12 to 13 distinct explosions resembling musketry fire.

Shepard [3] refers to a note upon the fall by Vaux and McEuen [2] but the reference given by Shepard must be incorrect as no mention is made of the meteorite in the place quoted. Shepard's account is as follows:

I am indebted to Dr. Elwyn, the treasurer of the association, for a reference to the notice of the meteorite of Deal by Mr. Robert Vaux and Dr. Thomas M'Euen, published in volume 16, page 181, of the transactions of the Academy of Natural Sciences (Philadelphia); and still further to the curators of the academy for a few grains of the stone, detached from their specimen (of rather more than half an ounce weight), which has enabled me to extend the account of its properties beyond the following brief remark, which is all that is embraced on this head in the paper above referred to, viz: "The stone is 3 inches in its greatest length, and the surface black with many indentations."

Its specific gravity is 3.25 to 3.30.

Its coating is perfectly black, but without the glassy luster. In some spots it penetrates by narrow veins and chinks into the mass of the stone for a slight distance.

It is of a light color within (destitute of rust points), and has a vitreo-pearly luster. Nickeliferous iron is distributed through it in minute shining globules, with here and there bronze-colored specks of magnetic iron pyrites. The stone is slightly coherent, and appears to be destitute of rounded concretions.

The metallic portion is rich in nickel. The earthy part is readily attacked by hydrochloric acid; and the solution formed contains silica, oxide of iron and magnesia, apparently in the proportions of howardite.

The stone may therefore be regarded as nearly identical with that of Castine (May 20, 1848) and of Poltawa (March 12, 1811).

Brezina [4] classed the meteorite as an intermediate chondrite. Nothing further seems to be known of the meteorite. Wülfing [5] accounts for 10 grams, of which Paris possesses 5 grams, and the Shepard collection in Washington 4 grams.

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Decatur County. See Prairie Dog Creek.

DE CEWSVILLE.

Haldimand County, Ontario, Canada.
Latitude 42° 57′ N., longitude 79° 56′ W.
Stone. White chondrite (Cw) of Brezina.
Fell 2 p. m., January 21, 1887; described 1890.
Weight, 340 grams (0.7 lb.).

This meteorite was described by Howell [1] as follows:

This aerolite fell in the village of De Cewsville, Ontario, Canada, about 2 p. m., January 21, 1887, striking in the ditch on the south side of the street known as Talbot Road, opposite lot 43, concession 1. The ditch at the time contained about a foot of water from a recent thaw, which was covered with thin ice. The meteorite made a hole in this ice about a foot in diameter. The whizzing noise in the air and the splash in the water were heard, and the latter was seen by a Mrs. Leonard Strohm, who was walking along the middle of the street and was only about 15 feet distant. Her first thought was that some one had thrown a snowball. The noise made by its passage through the air seems to have been heard with about equal distinctness by two men who were engaged in conversation, Mr. Drinkwater and Mr. Jacob Strohm, one sitting in his sleigh in the middle of the road and the other standing by a pump in his barnyard, on the south side of the road, about 150 yards west of where the meteorite fell. This fact, together with the further fact that the meteorite, after striking the ice and frozen ground in the bottom of the ditch, seems to have passed 3 or 4 feet to the eastward, indicates pretty clearly that it came from the west, and the impression of at least one of the persons who heard it, Mr. Strohm, whom I saw and questioned, was that it came from the west or a little north of west. Search was at once made for the stone by Mr. Strohm and others, but without success, and the spot where it struck was marked by cutting a notch in the fence near by.

After the melting of the snow and ice the stone was found by William Kinear while on his way to school, on the morning of February 16, about 3 or 4 feet to the east of where it struck.

As the specimen has been kept intact, no analysis has been made of it.

Its specific gravity, 3.52, is somewhat greater than most aerolites and it doubtless contains a little more iron than meteorites of its class.

Brezina [2] further described the stone as follows:

The single stone of this fall, weighing 340 grams, has the form of the segment of a sphere, such as would be produced by four radial cracks in a spherical shell 6 cm. thick and of large radius (about 30 cm.). The outer, slightly convex, spherical surface, as well as the corresponding inner, approximately concave surface, is extraordinarily glazed with a thick, primary crust; the converging flat sides have somewhat more prominence, although they possess also a primary character; on several corners and angles small fragments have been broken off and the fractured surface has been covered with a secondary crust. The primitive crust is thick and dark, the secondary is of a reddish brown color.

The stone is preserved almost entire in the Vienna museum.

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DEEP SPRINGS.

Deep Springs Farm, Rockingham County, North Carolina.
Latitude 36° 20′ N., longitude 79° 35′ W.
Iron. Nickel-rich ataxite, Morradal group of Brezina.
Found about 1846; described 1890.
Weight, 11.5 kgs. (25 lbs.).

This meteorite was first described by Venable [1] as follows:

This mass was reported to have fallen about the year 1846, near the old Mansion House, Deep Springs Farm, in Rockingham County, North Carolina. One of the old negro servants related to Mr. Lindsay, the owner of the farm, that "the rock fell on a clear morning and struck the ground about a hundred yards back of the garden. It frightened everyone very much. Col. James Scales, the owner of the farm at that time, and Mr. Dillard took a man and went to the spot and dug in about 4 or 5 feet and got it out." It lay about the house as a curiosity for several years, when it ceased to be of any more interest and was thrown aside. After Mr. T. B. Lindsay bought the farm, he kept the meteoric mass for several years upon the porch. In the fall of 1889, he presented it to the State Museum. The indentation in the earth where it is reported to have struck is still pointed out.

The weight of the mass was 11.5 kilograms. It had somewhat the outline of a rhomboid, measuring 270 by 210 mm., and having a thickness which varied from 10 to 70 mm. It is coated with oxidation products to a depth in places of several millimeters. These give the whole mass a dull reddish brown color. The surface is irregularly pitted with broad shallow pits. It is somewhat concave on one side. On being polished and etched it gave faintly the Wiedmannstätten figures. It belongs to the class of sweating meteorites, beads of deliquescent ferric chlorine appearing on the surface. This lawrenceite, so called, is evidently unevenly distributed through the mass. Analyses from different portions gave different amounts of chlorine, the less the deeper the material examined. In one boring it was noticed that the metal near the surface (within 2 cm.) gave a decided percentage of chlorine, while that coming from the deeper part of the drill hole (3 to 5 cm. from the surface) gave no appreciable amount of chlorine.

The analysis gave:

Fe	Ni	Co	Cu	Cr	C	Cl	P	S	SiO_2	
87.01	11.69	0.79	0.00	0.00	0.00	0.39	0.04	0.00	0.53	=100.45

Cohen [2] described the structure as follows:

On cutting a piece for chemical investigation the saw blade struck in the middle of the plate an irresistible obstacle, so that the cutting had to be carried on from the other surface and separation obtained by breaking. The character of this small layer of so great hardness I could not determine. A part of the section remained unchanged on etching. The portion bounded by the natural surface of the meteorite is covered with a layer of rust, as is the case with the Cape iron. The nickel iron rusts very easily and contains, as shown by the analysis, chlorine in large quantity. In this meteorite, as in the Cape, Lick Creek, and other irons, the abundant grains of iron chloride may be traced to sharply bounded portions with greater porosity, although a structural difference between the portions of the iron rich and poor in chlorine can not be recognized under the microscope. Besides being in the porous spots the iron chloride was probably originally pretty uniformly distributed in the meteorite. On weak etching, the section appears dull and completely homogeneous. On strong etching it takes a weakly granular appearance. Under the microscope there appear in large number minute, strongly reflecting particles, partly in the form of points, though at times in the form of light lines which have a length of 0.02 mm. and a breadth of 0.005 mm. Although the latter are generally oriented in different directions and pretty uniformly distributed, there is visible under the microscope a very slight grouping which give a spotted appearance on an etched surface. The iron seems to be constructed of very fine grains whose separation is not distinct even on strong magnification. The only accessory constituents are small flakes of schreibersite and

rhabdite, the latter reaching a length of 0.3 mm. and a breadth of 0.03 mm. According to information kindly given by Doctor Farrington, the section in the Field Columbian Museum 75 sq. cm. in size, shows 3 small troilite inclusions averaging about 2 mm. in diameter.

Analysis by Dr. J. Fahrenhorst gave the following:

Fe	Ni	Co	Cu	C	Cr	Cl	P	S	
85.99	13.4	0.70	0.03	0.03	0.02	0.02	0.06	0.00	=100.29

This analysis shows chromium but not sulphur to be present. The chromium can not, therefore, be considered to be present as daubreelite. Since a higher content of chlorine was found in the easily rusted portion a piece weighing 4.659 grams was used for a special determination. This showed 0.99 per cent of chlorine.

The following mineralogical composition of the iron may thus be determined:

	Portion rich in chlorine.	Portion poor in chlorine.
Nickel iron	99.57	97.87
Schreibersite	0.39	0.38
Lawrencite	0.04	1.75
	100.00	100.00

The specific gravity was determined by Dr. Ziegler at 22° C. to be 7.4538. A medium content of iron chloride (0.60 per cent) would give a calculated specific gravity for the nickel iron of 7.5443. This value is very low for an iron so rich in nickel and probably indicates a porous structure in the easily rusted portion. Deep Springs stands by reason of its content of nickel and cobalt nearer the nickel-rich than the nickel-poor ataxites. Nevertheless it seems to me better to group it with the latter on account of its structure and physical properties, which differ essentially from those of the nickel-rich ataxites.

The meteorite is chiefly (5,444 grams) in the possession of the North Carolina State Museum, Raleigh, North Carolina. In addition, Ward has 738 grams, Chicago 420 grams, and Berlin 314 grams.

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Dekalb County. See Smithville.

DENTON COUNTY.

Texas.
Latitude 33° 12′ N., longitude 97° 10′ W. approximately.
Iron. Medium octahedrite (Om) of Brezina; Caillite (type 18) of Meunier.
Known since 1856; described 1860.
Weight, 20 kgs. (40 lbs.).

This meteorite was first described by Shumard [1] as follows:

Since writing the above the Texas State cabinet has been enriched with another mass of meteoric iron, somewhat similar in composition to the Brazos specimen but of much smaller size. All that we have been able to gather of the history of this meteorite is that it was picked up in Denton County, in the northern part of this State, and thence conveyed by the finder to McKinney, in Collin County, and presented to a blacksmith of that place, in whose possession it remained for several months. In December last Mr. Higby, of McKinney, brought me a small hammered specimen of this iron weighing 40 grains. He stated that the mass from which he had taken the specimen weighed about 40 pounds when it arrived in McKinney, but that the blacksmith had cut off several pieces, which he had wrought into cane heads and various implements so that its original size had been much reduced.

During last winter Dr. G. G. Shumard procured from the blacksmith a piece weighing 12 pounds 5.5 ounces, which, after strict inquiry, was all that could be found of the original mass.

This piece is of an irregular shape and appears to have formed the middle portion of an elongated mass, though in its present condition we can form no very definite opinion with regard to its original shape. The iron is remarkably close textured and appears to be quite as malleable as the Brazos iron. Specific gravity, 7.6698.

The chemical composition, as determined by Prof. W. P. Riddell, is:

Residue insoluble in NO_3	0.32814
Iron (mean of three determinations)	94.02466
Nickel	5.42982
Cobalt	Trace.
	99.78262

Little further account has been given of the meteorite.

Analysis was made by Madelung [2] on a specimen having a specific gravity of 7.42, with the following result:

Fe	Ni	Co	P	Insol.	
92.099	7.530	Trace	0.001	Trace	=99.63

Brezina,[3] in his 1885 catalogue, speaks of the iron as follows:

Denton County is not well disclosed; kamacite somewhat puffy, bands 0.3 mm. wide.

Meunier [4] in 1893, describes it as follows:

The kamacite is in pretty large bands, separated from each other at many points and only by fine laminæ of tænite. The plessite is less abundant and is unequally distributed. The metal incloses numerous grains of schreibersite; no pyrrhotine is visible.

Small pieces of the meteorite are reported in various collections. The main mass is said to be in the State Museum at Austin, Texas.

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Denver. See Bear Creek.

Denver County. See Bear Creek.

DESCUBRIDORA.

District of Catorze, State of San Luis Potosi, Mexico.
Here also Catorce (found 1885) and Agua Blanca (which has been lost).
Latitude 23° 44′ N., longitude 100° 58′ W.
Iron. Medium octahedrite (Om) of Brezina; Schwetzite (type 15) of Meunier.
Known since 1780–1783; mentioned 1804.
Weight: Two masses, one of 576 kg. (1,270 lbs.), the other of 41.5 kg. (90 lbs.). The weight of other masses referred to here is not known.

In the view of Brezina [25] the following masses should be grouped here. He says:

Under the name Descubridora are to be classed at least the following:

(1) The large mass of 576 kg. weight which, according to Castillo,[21] was found before 1780 (or 1783) in the Descubridora Mountains upon the Hacienda de Poblazon, and brought from there to the stamp mill of San Miguel. It was there converted into an anvil, and later brought to the Hacienda del Tanque de Dolores, then once more to the Hacienda San Miguel, and from thence to the Geographico-Statistical Society of Mexico, through the efforts of M. Yrizar. The Vienna specimen agrees exactly with the Durango iron, and relatively with Pila, with Catorze, and with the Descubridora specimen of Yale College. The kamacite glistens brightly, the tænite is well developed, and the fields resemble the bands. This iron is identical with that of the Hacienda de Vanegas (not Venagas), from which I erroneously concluded that it was a hexahedral iron of nearly cylindrical form.

(2) An iron from Descubridora put on the market by Ward and Howell, which was obtained from the Yale College collection. This iron has straight, notched laminæ of medium, almost fine, breadth, and with kamacite and plessite in specks.

(3) The iron of Catorze of 41.5 kg. weight, described by Geo. F. Kunz, now in the Vienna Museum, in which a groove had been chiseled, evidently for the purpose of cutting off a fragment, in which there remained the broken end of a copper chisel. The etched surface shows complete agreement with the first two irons and also great similarity with Morito.

(4) According to Fletcher, an iron of 4.5 to 5.5 kg. weight, in the possession of a certain Chialiva at Zacatecas.

(5) The iron from Real del Guangoche, near Catorze.

(6) The iron of Agua Blanca, near Catorze.

The Charcas iron, which Fletcher indicated as apparently belonging also to the Descubridora iron, is provisionally regarded as an independent mass because of its somewhat finer figures, but especially because of the intermixture of a peculiar powder-like substance. A thorough chemical investigation is necessary to determine accurately the chemical constituents of this mass.

Of the masses mentioned in the foregoing, the most important is the one weighing 576 kg., which was fully described by Burkart [12] as follows:

In the year 1830 I learned of the existence of a large mass of meteoric iron within the bounds of the Hacienda of Poblazon, and soon afterwards I saw a smaller meteoric iron mass in the possession of a friend, said to have come from the neighborhood of Alamos de Catorze. Later, in 1856, I learned that the mass from Poblazon, estimated at 18 cm. weight, had been brought by a Mr. Aguilar to his amalgam works situated at Catorze, in order to make of it a base for a stamp mill for this work; and in the course of the year 1873, Prof. Don Antonio del Castillo, of Mexico, informed me that this meteorite had been brought from San Luis Potosi to the capital city of Mexico without, however, stating how, when, or from whence the same had come to San Luis Potosi. Further particulars concerning this iron meteorite, only the locality of which has been known hitherto, are found in the journals of two Mexican scientific societies for geography and statistics and for natural history, from which, therefore, we have drawn the following:

The Society for Geography and Statistics obtained already in the year 1871 an iron meteorite sent from San Luis Potosi, and later also, according to their desire, an historical notice of the same. They appointed a commission to investigate and describe the meteorite, which, with reference to its approximate place of discovery, they designated as the aerolite of Descubridora, and to install the same in the building used by the society as the nucleus, with other objects already in hand, of a collection of natural products and works of art. This determination, however, was later changed and a distribution of the mass, under the direction of the commission, was determined upon in order to be able to make an exhaustive investigation of it. This determination called forth sharp censure from different quarters because the great meteoric iron mass was at the time regarded as Mexico's finest meteorite, and its destruction was given up in order to preserve it inviolate for posterity. * * *

The meteorite of Poblazon was found certainly between the years 1780 and 1783 upon the mountain of Descubridora, in the neighborhood of the mining region of Alamos de Catorze, a district noted for its rich diggings of silver ore, and therefore even yet designated as Descubridora. It reached San Luis Potosi in the year 1871, in charge of Vicento Irizar, for the Society of Geography and Statistics in Mexico.

Its form was described as that of a distinctly marked prism, with an egg-shaped base of 90 cm. Its weight was given as 575 kg., and it was noted that its mass was of a whitish, steel-gray color, very tough, of a fibrous texture, and, on account of its great density, capable of taking a beautiful polish.

The mass was cut in two pieces, the larger of which was 60 cm. long. From this, however, there had been cut a slice 4 cm. thick which was said to have been divided up into smaller pieces among the public collections and chemical laboratories of the land.

The section surfaces of both the larger pieces are said to have been engraved, upon one surface the national arms, upon the other information as to the place of find, the date of same, the name of the donor, the original weight, the volume, the results of analysis, and the physical characteristics of the meteorite. The particles resulting from the cutting of the iron are said to have been used for the purpose of manufacturing a knife blade, an elastic spring, a wire, etc., in order to determine the malleability, hardness, and toughness, as well as the practical uses of the meteorite; then, according to the specifications in the instructions of the commission of the Society of Geography and Statistics, the smith of the Hacienda San Miguel, near Poblazon, had already made hatchets and nails of a few fragments cut from the meteorite which, on account of their durability, were very much prized.

The mass must, therefore, at an earlier time have been larger, heavier, and of somewhat different form than it appears to have been at the time of its investigation in Mexico, even though Aguilar, its former owner, is said not to have carried out his intention of making a stamp mill base of the iron.

In the second of the foregoing, the commission of the Society of Natural History gave a somewhat more complete description of the meteorite of Poblazon, or Descubridora. They found at the beginning of their activity that the meteorite had already been cut in two, and they could not, therefore, as they themselves assert, form an even approximately correct idea of its general form, but concluded from the form of the piece and from the data in the first report that the meteorite had a distinctly pyramidal form.

In the meantime, however, the commission had also obtained photographs which had been taken from the iron mass in San Luis Potosi, and which are said to have shown the three flat surfaces of the pyramid. These surfaces show in their outline a few straight lines which for the most part correspond to the direction of the cleavage planes, since by prolonging the most distinct of these lines, according to the opinion of the commission, figures should be obtained which resemble the figures obtained by treating the polished surfaces of the meteorite with nitric acid, and among the angles formed by the intersection of the lines, the angle of 109°, corresponding to the octahedron, may often be recognized. Moreover, the commission noted, upon one of the surfaces, a crack parallel with the line of the contour, and between the two another blackish line which meets with the line proceeding from another point.

The color of the iron in places exposed to the atmosphere is brownish-black; in some other places on which schreibersite appears to be exposed it is, on the contrary, silver white, and upon a fresh fracture whitish, steel-gray. It shows a distinct crystalline structure, and has in general a little metallic luster, but on the oxidized exterior is dull. Hardness=8; flexible and malleable; specific gravity=7.38. Both poles of the magnetic needle were attracted by the iron.

On the inside of the meteorite occur some cavities which were filled with a crystalline, earthy (?) mass of *speiss gelbe* color shading into tom-back brown, and with a metallic luster, the troilite of Haidinger or iron sulphide.

Analysis by Patricio Murphy:

Fe	Ni	Co	S	Cr, P, O loss	
89.51	8.05	1.94	0.45	0.05	=100

Etching on polished surface produces distinct Widmannstätten figures like those of the Xiquipilco iron.

In view of the above-given characteristics, the commission referred the iron to the holosiderites of Daubrée.

The commission furthermore cited the result of different experiments with the meteorite of Descubridora, of which the following data may find place here.

The piece of the meteorite used for the experiment showed especially a prismatic or cubic form which was also indicated by the fracture.

The resistance of the iron to crushing was 38 kg. (upon a cross section of 1 sq. mm.); resistance to tension 40 kg., etc.,

Much of Burkart's account seems to have been drawn from Barcena's [11] description. Barcena [13] later summarized this before the Philadelphia Academy as follows:

In the State of San Luis Potosi two aerolites of large dimensions were found. One of them, called "Meteorito de la Descubridora," was sent 4 years ago to the Mexican Society of Geography and Statistics of the City of Mexico by Messrs. Cabrera and Yrizar of the city of San Luis Potosi. This mass, which weighed 576 kg., was divided in several pieces for the purpose of making some investigations as to its structure. The form of the meteorite was also prismatic; it resembled that of a pyramid with a triangular base; the drawing taken with a photographic apparatus presented in its outline several well-determined lines which formed triangular and quadrilateral figures very similar to those produced by hydrochloric acid upon the polished surface of the same mass. The color of the aerolite is grayish white and its texture notably crystalline. Its specific weight is 7.38. It is composed of:

Fe	Ni	Co	S	Cr	Loss	
89.51	8.05	1.94	0.45	trace	0.05	=100

The resistance of the iron to rupture by compression is 38 kg. to the square millimeter; the resistance to the rupture by extension is 40 kg., being the section of the metallic thread of a square millimeter. The coefficient of linear dilatation between 0° and 100° is 0.0000701.

The analysis of the meteorite in question was made by the Mexican chemist Don Patricio Murphy. The other studies were made by a commission of which I had the honor of being a member.

The 92-pound mass was first described by Kunz [19] as follows:

The Catorze mass, weighing 92 pounds, was found by a miner near Catorze, San Luis Potosi, Mexico, in 1885. It measures 31.5 by 34.5 by 20 cm. It shows beautiful raised octahedral markings. On one side an opening 9 cm. long has been made and a piece of a chisel of native copper left in it. This piece, which is partially covered with oxide of copper, is 22 mm. long on one side, 33 mm. on the other, and 14 mm. wide.

This iron is one of the Cailite group of Stanislaus Meunier and shows the Widmannstätten lines very finely. It resembles the irons of Augusta County, Virginia, of Glorieta Mountain, and others of this group. No troilite was observed, the mass having been cut very little and schreibersite is only sparingly present.

Analysis by J. B. Mackintosh:

Fe	Ni and Co	P	Insoluble in HNO_3	
90.09	9.07	0.24	0.60	=100

Specific gravity, 7.509.

This iron Kunz regarded "from all appearances" as a "new and distinct fall."

Castillo [21] mentions only the 576 kg. mass and describes a peculiar mineral which he found in it.

Fletcher's [22] views have already been referred to.

Meunier [24] makes the following observations:

The figures produced by this iron are identical with those of the Schwetz iron. The kamacite is composed of bands more than a millimeter in size and the sides of the plessite, which are often square, are on an average 4 mm. in size. The latter show under the glass very small specks of schreibersite. The kamacite is often bordered by a very fine lamina of tænite. The pyrrhotine occurs in very elongated masses.

The large mass is now in the Mexican National Museum. It is cut in two parts and the parts bound with iron hoops to prevent their falling apart from the fissure already referred to by Burkart as running through them. The surface of one of the masses is nicely engraved with the locality, weight, etc. The 92-pound mass is preserved almost entire in the Vienna Museum.

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DE SOTOVILLE.

Choctaw and Sumter Counties, Alabama.
Here also Tombigbee River.
Latitude 32° 13′ N., longitude 88° 10′ W.
Iron. Hexahedrite (H) of Brezina.
Found 1859 to 1886; described 1899.
Weight, six masses weighing 46 kgs. (96.5 lbs.).

The history and characters of this meteorite have been summarized by Cohen [6] as follows:

In 1899, W. M. Foote [1] described six masses of iron from Alabama, three of which were found south of De Soto-ville, in Choctaw County, and three north of the same place in Sumter County. They were found at points lying in nearly a straight line 16 km. in length and at almost equal distance from the Tombigbee River, the masses being arranged in order of weight, the heavier ones at the north and decreasing in weight toward the south. Foote chose the name "Tombigbee River" for these new meteoric irons; but as this stream traverses the State of Alabama for a distance of nearly 300 km., it does not locate the place of discovery very definitely, and accordingly the designation, De Sotoville, is to be preferred.

The following data as to the weight and date and place of discovery of these six masses are given:

I. 15.019 g.; found 1878; apparently cast upon the surface by the uprooting of a tree.
II. 11,976 g.; found 1886 by a plowman; of an irregularly rounded form.
III. 9,215 g.; found 1886; form similar to II.
IV. 3,568 g.; found in the making of a road; flat and elongated.
V. 3,260 g.; found by a plowman; egg-shaped.
VI. 757 g.; found 1859; flat and oval; a portion of it was wrought up into nails, so that its original weight was greater.

The formation of the rust coating was accompanied by the occurrence of reddish-brown drops, and according to the statement of the finder of No. I, its weight in 1878 was 22,200 grams, so that in 21 years a diminution of 7,181 grams was produced by the formation of rust, since the form does not permit the supposition that a piece was cut off. The mention of platter-shaped depressions upon the exterior makes such a marked diminution of volume not entirely probable.

If the loss in weight of Nos. I and II be taken into account, the total original weight would be about 51 kg.

Masses III and V were more closely examined by Foote. Upon No. V he observed a distinct cleavability, which was referred to thin plates of a pyritiferous mineral; upon cut surfaces these appeared as sharply scratched lines. Upon etching this soft and easily polished iron it shows cubic crystallization, the Widmannstätten figures being composed of extraordinarily fine, microscopic lines which intersect at various angles. Mass III shows a different etching surface, since it lacks the figures of No. I. A portion of the plessite shows an appearance suggestive of metallic sheen, due to the arrangement of tin-white bladelets or cracks; another portion of the plessite remains entirely smooth.

Berwerth [2] placed De Sotoville (Tombigbee) among the ataxites. Klein [4] assumed that it belonged to the finest octahedrites, but pointed out that it needed closer investigation. Farrington [5] called attention to its cubic characters and advised further examination.

All three of the samples examined by Brezina and Cohen [5] (consisting of a portion of No. I, weighing 1,054 grams and measuring 135 cm.; a portion of No. III, weighing 570 grams and measuring 75 cm.; and a portion of No. VI, weighing 243 grams and measuring 38 cm.) are characterized by abundant schreibersite in elongated, twisted individuals with hook or loop like conformation. In respect to the size and manifold form of the schreibersite, De Sotoville exceeds all known meteorites except Primitiva. Other shapes and forms resembling hieroglyphics also occur. Rhabdite also occurs, sometimes isolated, but mostly compacted together in groups, and then in a twofold formation and arrangement. In many places the needles attain a length of 3 mm.; they appear to be arranged according to three directions, so that two of these intersect at an angle of 90°, and the third runs diagonally. Their occurrence in layers separated some 1.5 cm. from one another, is extremely various, as well as the lengthening of the latter. Sometimes they traverse completely a large plate, sometimes they can be followed only for a short distance. Schreibersite is entirely wanting for some distance, where rhabdite accumulates in larger quantities. Finally, in many places near the natural exterior, giant rhabdites occur; these are from 0.05 to 0.15 mm. wide and as much as 2 cm. long, and sometimes lie parallel to one another; sometimes they intersect at various angles, apparently without regularity. Should there occur here also a regular orientation, still there is another as in the case of the elongated rhabdites.

Most of the giant rhabdites remained rough and lusterless after etching, as if not entirely unchanged. All the rhabdites are surrounded with a highly lustrous etching zone, a feature which is the exception in the case of the large schreibersites and then only on portions of the crystals.

It appears to be the giant rhabdite which Foote mentions as the "pyritiferous mineral"; on the contrary, however, the analyses sometimes show no sulphur at all, and only small masses of it at most in other cases. At all events, iron sulphide has not been observed in visible particles, which, considering the size of the cut surfaces examined, appears quite remarkable.

"Eisenglas" frequently occurs on the edge of the plates, and this usually incloses and sometimes penetrates large schreibersites. After dislodging the crystals there remains a thin black film clinging to the nickel-iron; it is partially covered over with a brown coating, which, contrary to expectation, gives no chlorine reaction.

Brezina and Cohen [5] give the following analysis of the schreibersite from carefully selected material:

Fe	Ni	Co	P	Residue.	
71.70	12.58	0.32	15.45	0.15	=100.20

Accordingly this schreibersite belongs to the variety which contains the least nickel of any yet investigated. It would be interesting also to determine whether the rhabdite, as usual, is here characterized by a higher content of nickel.

While the accessory ingredients and their occurrence are the same in all three masses, the structure is so divergent that a separate description seems to be desirable.

In the case of No. I, after moderate etching, densely compacted Neumann lines appear, which are of such fineness as scarcely to be noticeable to the naked eye; under the glass, however, they appear with extraordinary distinctness. From the various line systems a few are distinguished, as usual, by greater length than the others, but not by a corresponding depth and breadth, as is usually the case in other hexahedrites. As a rule, the etching lines contrast sharply with the large schreibersites, and only occasionally is a slight faulting observed. Disregarding the latter purely local phenomenon, the former extends with similar orientation over the entire surface of the section. At this stage of the etching, the etched surface takes on such a bright, atlas-like sheen that portions with stronger or weaker reflection may be distinguished, which, by turning the plate, gradually pass into one another. The difference in the behavior of individual portions in direct light seems to be due to the fact that in places only Neumann lines are present, while on other portions etching pits occur which gradually increase in number and thus render the lines indistinct. At all events it is easy to see that an oriented luster can only be conditioned by etching lines, and that the occurrence of etching pits does not increase the distinctness of this sheen. This is easily explainable also, since the pittings are bordered by hexahedral facets, but the surfaces laid bare by the etching out of the twin lamellæ run in different directions, and now one and now another reflection will determine the sheen. By further etching, the lines and pits become broader and deeper and new etching lines seem to be added; finally, the smooth, lustrous little areas between the Neumann lines become rounded lumps, the entire etched surface takes on a rippled, lumpy appearance, and the former strongly and uniformly oriented sheen now becomes dull because of diffuse reflection. Adjacent to the schreibersite the hexahedral iron shows numerous etching zones 0.3 to 0.5 mm. wide, upon which, after etching, the iron remains bright gray, while it becomes dark gray at a distance from the schreibersite. The same thing occurs in the neighborhood of the rhabdite.

If it be concluded from the regular course of the Neumann lines and from the compact, parallel layers of rhabdite, as well as from its orientation within the layers, that the entire mass is an individual of the structure of a hexahedrite, this result becomes established if a plate be half cut through and then broken. The fractured surface leaves signs of cleavage which are oriented in three directions perpendicular to one another. Larger continuous cleavage surfaces are entirely wanting, since the division usually takes place along the borders of the schreibersite and the cleavage is thereby interrupted.

The etched surface of No. VI shows a silken sheen which here, however, appears peculiarly burnt, as in the case of Primitiva. The Neumann lines almost disappear; they can only be seen under a strong glass and then are confined almost entirely to those portions of the nickel-iron which lie in the vicinity of large schreibersites or are enveloped in growth forms of the same. Besides or instead of the etching lines, fine, short, slightly crumpled cracks occur everywhere and run parallel to one another and in the main parallel to the direction of the velvety sheen. Very fine, straight Neumann lines appear whose breadths have been determined under the microscope as 0.003 to 0.004 mm., running prin-

cipally in two directions, which include between them an angle of 55°. The wavy lines are much broader (0.04 to 0.05 mm.) and, at least in the portions not disturbed, almost follow the longer diagonal of the rhombus formed by the sharp lines (measuring angles of 38, 17 to 30, and 25°). The wavy lines frequently are situated with their ends upon a line system inclined at an angle of 55°. In two places a considerable disturbance slightly bends the sharp lines and has a similar though more considerable effect upon the wavy lines. The elongated islet of iron in the middle beneath appears to be turned toward the iron particles beyond the schreibersite at an angle of about 8°. The two sharp and the wavy line systems seem to show closely compacted line systems, the first of which is inclined perpendicular to the section surface, the latter very level with it.

Besides these structural lines still another structural element is visible. First of all a vein, which runs in a double curve from the middle above to the uppermost point of the schreibersite, then extends toward the upper left branch of the schreibersite crystal, penetrates this at a slight angle of deviation, and, parallel with the downward curved portion of the branch, a piece runs into the large bay. This vein is fine grained and spotted but does not lie in a granular groundmass. Another phenomenon is the occasional granulation running entirely independent of the Neumann lines which it penetrates. The abundant layers of rhabdite, here uniformly fine and short, are for the most part surrounded by grains of nickel-iron 0.05 to 0.3 mm. in size, which frequently are confined to the immediate neighborhood of the needles and are then situated like berries on a branch. Also, lengthwise of a giant rhabdite, or of the individual faces of large schreibersites, as well as of finer irregular cracks, a small fine-grained zone occurs, but the entire granular portions compose a very small part of the total section surface.

The greater portion of the nickel-iron of No. III is scattered in irregular sharply defined grains—roundish, longish, bent, and jagged—every portion of which has the same strongly oriented sheen. The diameter of the grains is between 0.2 and 1.5 mm., and the form is in general the more irregular the greater the dimensions. In some places particles of a very fine-grained structure predominate with characteristic oriented sheen in which, however, are found large grains, singly or in groups, with different sheen. As in No. VI, so here also a row of brightly glistening grains lies directly along the giant rhabdite, where they stand out sharply. Under the microscope these grains appear in part spotted and then less glistening, and in part full of compact lattice-like etching lines, and then with lively oriented sheen. Here and there—especially where particles of nickel-iron become inclosed by branching schreibersite or interjected between neighboring larger schreibersite—lie isolated grains with a smooth etched surface, and the groundmass then shows Neumann lines, which are unmistakable, although their development is much less complete than in No. I.

Independent of the grains is a network of fine, irregularly meandering cracks, occasionally breaking through the former, therefore of later origin. They appear even after weak etching, provided the granular structure does not make itself perceptible, and are to be regarded as a segregation phenomenon.

Very noteworthy is the already mentioned fine-grained, microscopically compact-appearing portion which traverses the entire plate, and which appears as a vein 1 to 3 mm. in breadth, which is sharply marked off by a small border zone filled with dark dust-like particles. It penetrates one of the giant rhabdites, which appears to be displaced about 2 mm.

The following analyses of Masses I, III, and V are given:

1. Mass I, Dr. R. Knauer and E. Cohen.
2. Mass III, Dr. O. Hildebrand and E. Cohen.
3. Mass III, Dr. R. Knauer.
4. Mass V, J. E. Whitfield.

a gives the total composition, *b* the composition of the nickel-iron after abstraction of accessory material, *c* the mineralogical composition of the masses.

	1*a*	2*a*	3*a*	4*a*
Fe	95.41	95.18	95.14	95.02
Ni	4.04	4.32	4.82	4.11
Co	0.74	0.69		0.40
Cr	0.02	.....	0.01	.....
Cu	0.04	0.04	0.05	.....
C	.....	0.07	.....	0.16
P	0.14	0.20	0.29	0.32
S	0.05	.....	0.06	Trace.
Cl	.....	0.00	.....	.....
Residue	0.02	.....	.....	.....
	100.46	100.50	100.37	100.01

	1*b*	2*b*	3*b*	4*b*
Fe	95.40	95.22	95.60	95.86
Ni	3.83	4.02	4.34	3.62
Co	0.71	0.65		0.36
Cr	0.02	0.00	0.01	.....
Cu	0.04	0.04	0.05	.....
C	.....	0.07	.....	0.16
	100.00	100.00	100.00	100.00

	1c	2c	3c	4c
Nickel-iron	98.93	98.71	97.96	97.89
Schreibersite	0.91	1.29	1.88	2.11
Troilite	0.14	.....	0.16	.....
Residue	0.02	.....	.....	.....
	100.00	100.00	100.00	100.00

The content of Ni and Co is the lowest which has hitherto been found in a meteoric iron, if only the newer, trustworthy analyses are taken into account.

On the one hand the chemical composition of the masses is identical; on the other hand, despite many differences of structure, many correspondences are also present. Mass I, considered by itself alone, may be regarded as hexahedral iron; Mass VI, as the same, though possessing in places a granular structure; while in Mass III only traces of Neumann lines are visible. On the other hand the occurrence of the giant rhabdite in Nos. I and III is entirely alike, likewise the characteristics of the veins. In addition, there is the nearness of the places of find, as well as the similarity of the accessory materials in respect to their unusual structure and arrangement. The connection of the masses as one fall is, therefore, not to be doubted.

It must be assumed that the various masses of the De Sotoville iron were originally normal hexahedrites and, in varying degree or extent, were subjected to agencies which wrought a change of structure. Probably different degrees of heating may account for the differences, which in the case of some of the masses, may have been carried to the extent of softening or of complete melting of the entire mass. The end piece of Mass VI would represent a slight degree of alteration, in which case only the twin structure has really disappeared, and a granular texture in a few places of very limited extent has attained full development. In the case of Mass III, however, almost the entire mass has taken on a granular structure and the twin lamellæ only in places remain so far intact as to show definite indications of Neumann lines. It can not be determined with certainty whether the masses in question were heated by their finders, as so often happens in the case of meteoric iron, or whether a secondary softening took place before or during their fall.

In addition to the heating there must also have been some mechanical process to produce the faulting and bending of the Neumann lines as well as the displacement and formation of veins.

The mechanical changes could in no case have been brought about by artificial means, since such means would be far too coarse to produce so delicate displacements on such an enormous scale.

Since, however, in the neighborhood of the displacements and veins, occur structural changes similar to those of the apparently thermally altered portions, the conclusion may be drawn that the thermal process is also not of artificial, terrestrial origin, but of the same cosmic nature as the mechanical changes; and that through heating and pressure there was a gradual change of a hexahedral iron into an ataxite.

The meteorites are distributed.

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Dickson County. See Charlotte.
Dolores Hidalgo. See Cosina.

DRAKE CREEK.

Sumner County, Tennessee.
Here also Sumner County, Somner County, Nashville, and Tennessee, 1830.
Latitude 36° 21′ N., longitude 86° 32′ W.
Stone. Veined white chondrite (Cwa) of Brezina; Luceite (type 37, subtype 2) of Meunier.
Fell 4 p. m., May 9, 1827; mentioned 1830.
Weight. Five stones; the largest weighed 11 pounds, another 5¼ pounds.

The first mention of this meteorite was by Silliman,[1] who stated that the meteorite had been ordered sent to him by Professor Bowen, but on its way it had been left with Mr. Seybert for analysis. The methods of Seybert's analysis are given in considerable detail, but the results of an analysis of the undecomposable part, specific gravity 3.485, are as follows:

SiO^2	FeO	MnO	MgO	CaO	Al_2O_3	NiO(Co)	S	Fe_2O_3	Cr^2O_3	
40.000	12.000	.....	23.833	.....	2.466	2.166	2.443	12.200	0.833	=95.941

He also stated that the "mineral" consists of a friable, granular mass of a grayish color in which metallic particles are easily discernible to the naked eye. It is coated externally with a crust of a dark-brown color which shows evident marks of fusion. It is highly magnetic and when thrown into hydrochloric acid sulphureted hydrogen is evolved.

A brief account of the appearance of the meteorite was given by Silliman[2] later, as follows:

This meteorite stone which we have received presents a decidedly felspathic appearance, and is quite homogeneous except its black crust and the small metallic particles consisting of the protosulphuret of iron and native iron everywhere disseminated through its mass. Its specific gravity as ascertained by Mr. Seybert is 3.48. Of all the stones of this sort which have fallen in the United States it resembles the most nearly those of Maryland, from which it differs only in being of a color more nearly approaching to white.

A later notice by Silliman[3] was given of the circumstances of fall as follows, copying an account from the Nashville Banner:

This account, although published at the time in the Nashville Banner, has but recently been placed in our hands. As all such notices that are authentic ought to be preserved, it is now inserted in this journal. It is on the authority of the Rev. Hugh Kirkpatrick, who is spoken of as worthy of entire confidence.

On Wednesday, May 9, about 4 o'clock p. m., the day being as clear as usual, my son and servants were planting corn in the fields when they heard a report similar to that of a cannon, which was continued in the air resembling the firing of cannon or muskets by platoons and the beating of drums as in a battle. Some small clouds with a trail of black smoke made a terrific appearance and from them, without doubt, came a number of stones with a loud whizzing noise which struck the earth with a sound like that of a ponderous body. One of these stones my son heard fall about 50 yards from where he was. In its descent to the ground it struck a pawpaw tree of the size of a small handspike and tore it to pieces as lightning would have done; guided by the tree he immediately found the spot and there he found the stone about 8 or 10 inches under the ground; this stone weighed 5.25 pounds. Mr. James Dugge was also present. They stated that the stone was cold, but had the scent of sulphur.

On the same day and about the same time my son-in-law, Mr. Peter Ketsing, was in a field with his laborers about 1 mile distant when a stone fell which weighed 11.5 pounds. This took place near him, his wife, and three other women. A number of respectable men were present when it was found and taken up; it was 12 inches under the ground. I have seen one that fell at Mr. David Garrett's, and part of one that fell at Mr. John Bones's; I have also heard of one more that has been found. These stones are perfectly similar, glazed with a thin, black crust and bear the marks of having been through a body of fire and black smoke. Many gentlemen who have been excited within a few days to come to my home to see them say they never saw such before.

The editor of the paper says the noise was heard 10 or 12 miles or more.

I have nothing more to add to the description of this stone already published, except that the innumerable metallic points which are visible through the light gray (almost white) surface of the mass are nearly as brilliant as silver, although they have obviously been rounded by heat. They are attended by an immense number of brilliant, black, vitreous globules which have every appearance of perfect fusion and the entire mass has that harsh, acrid feel which belongs to lavas and trachytic rocks.

The black crust has evidently been in a state of at least pasty fusion; its roughnesses are rounded and on drawing a file over any of its prominent points bright metallic iron is immediately uncovered.

There is no account of a fireball attending these meteorites, but as it was full daylight and probably sunshine we can not conclude that there was no fireball. It is more probable that there was one.

The locality given above is northeast of Nashville. It is in Sumner County, and not Davidson County, in which Nashville is located. On account of the mention of Nashville in the above statement, however, the meteorite has often, though wrongly, been called by that name.

Von Baumhauer[4] obtained the following result by analysis (specific gravity = 3.469):

	Groundmass.	Crust.
SiO_2	58.75	60.49
FeO	22.70	32.10
MnO	2.08	.....
MgO	18.50	1.48
CaO	.30	.....
Al_2O_3	.23	.....
NiO	2.08	1.85
S	1.80	2.47
Sn	.10	.....
K_2O	.02	.....
Na_2O	.35	.....
	106.91	98.39

Brezina in 1885[7] placed the meteorite among the vein-free white chondrites, but in 1895,[8] on the ground of Reichenbach's statement that the mass was veined, changed its place to the veined chondrites.

The meteorite is distributed. Wülfing's[9] list accounts for 5,501 grams, of which Harvard possesses 1,481 grams and Leyden 2,222 grams.

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DUEL HILL.

Madison County, North Carolina.
Here also Duell Hill and Madison.
Latitude 35° 32′ N., longitude 82° 28′ W.
Iron. Coarse octahedrite (Og), of Brezina.
Found 1873; described 1876.
Weight, 11 kgs. (25 lbs.).

This meteorite, which has been at times combined with Jewell Hill, was first described by Burton[1] as follows:

This meteorite was placed in my hands for examination by Prof. F. H. Bradley, who also furnished the following facts in regard to its history:

"The mass was found in August, 1873, on land of Robert Farnesworth, near Duel Hill, Madison County, North Carolina. It was lying on a hillside where it had probably been used by the first settlers of the land for supporting the corner of a rail fence, now rotted away. It is said to have weighed when first found about 25 pounds. Two or three pounds of 'specimens' had been hammered off, most of which could not be recovered. Mr. Farnesworth reported that a similar mass weighing about 40 pounds had been found about a mile farther west before the war, perhaps about 1857, which has since disappeared, probably having become buried in rubbish."

This meteorite consists of metallic iron, of a rounded irregular shape, with the usual coating of magnetic oxide, and measuring 9 by 6.5 by 3.5 inches, and weighed 21 pounds. Over the surface at various points was a small bead-like deliquescence of iron chloride. A portion was cut off at a machine shop and was described by the machinist as "the toughest piece of iron" he ever handled. The usual markings were brought out by etching the polished surface, though they were rather indistinct; at the same time, distinct particles of schreibersite were developed, disseminated irregularly over the surface, which came out more prominently under prolonged action of the acid. Specific gravity, 7.46. Iron not passive. Dissolved in hydrochloric acid without liberation of sulphuretted hydrogen, leaving a very slight black carbonaceous residue which contained SiO_2, Fe, Cr, Ni, and P. The following result was obtained on about one gram of the iron:

Fe	Ni	Co	P	Cu	Residue	
94.24	5.17	0.37	0.14	50.	0.15	=100.07

Brezina,[2] in 1881, gave the following account of the structure of the meteorite:

A piece of this meteorite shows that it belongs to the group of the same iron which, like the one variety, Szlanicza (Arva), Caryfort, Sarepta, and Southeast Missouri, shows inclusions, in the midst of the coarse kamacite, of plates or, upon the section surface, of ribs of porous schreibersite. The specimen exhibits upon the kamacite by etching only a separation among grains of from 1 to 1.5 mm. in diameter, which indicates as plainly as possible that this iron must have been at some time subjected to a forge fire; by continuous action of the acid the familiar glimmer arising from the very regular striations appears quite distinctly upon the entire surface of the section. Interspaces are not very abundant, and are thickly filled with combs, so that the plessite is reduced to small amount.

In his 1885 catalogue, Brezina[3] grouped Duel Hill in the Arva group of coarse octahedrites. These are described as having

lamellæ long and abundant, grouped, generally weakly hatched and granulated, with strong oriented sheen; most of the bands containing inclusions of porous schreibersite. Breadth of the bands, 1.2 to 2.5 mm., mostly 1.5 mm.

Brezina says further:

These irons, which belong to the most beautiful iron meteorites, show characters peculiar to themselves. Owing to the generally strongly oriented sheen, in combination with evident grouping of the lamellæ in certain portions, large areas appear dark and others light, an appearance noted by Haidinger. The breadth of the bands in one iron (Duel Hill) falls so low that it belongs among irons with medium lamellæ. On the other hand, I have foreborne to subdivide the group because the appearance of all the irons of this group is so similar, and for the further reason that the plates of Duel Hill which I have examined are not large enough to allow a conclusion as to the whole of an iron whose structure changes so rapidly.

Further he states:

Duel Hill and Caryfort are intermediate between [coarse and medium octahedrites]. They have oriented sheen, hatching not prominent, hence kamacite strongly granulated in the former.

Genth and Kerr[4] simply repeat the statements of Burton. Fletcher[5] includes Duel Hill under Jewell Hill and says that the two irons probably belong to one fall.

Venable,[6] in his catalogue of North Carolina meteorites, under the title of "Madison Meteorites," gives Duel Hill as the locality and states:

There are several meteoric masses attributed to Duel Hill and to Jewel Hill, Madison County. The similarity of these names in pronunciation and apparent confusion between them led to inquiry as to their exact location. The result of the inquiry is that at present no Jewel Hill is known in this county. There was a Jewel Hill, at one time the county seat, but its name was changed to Duel Hill and the county seat removed to Marshall. These two are therefore one and the same locality.

Venable lists three masses from this locality. One, he states—

was found in 1856 and is recorded as preserved in the Amherst collection. It weighed 40 pounds. No analysis has been found. Amherst has two pieces, one of 600 grams and one of 167.5 grams.

The next one is the 8 pound mass described by Smith (see Jewell Hill), and the next the mass here described.

Brezina,[9] in 1895, objected to the uniting of the masses of Jewell Hill and Duel Hill by Fletcher, on account of their great differences in structure and composition. Their difference in structure he illustrates by two plates. Further he says:

Duel Hill is distinguished by the appearance of large troilite cylinders lying parallel to one another; in a complete transverse section in the Vienna collection is one 15 cm. in length by 1 to 1.8 cm. in thickness which is inclosed throughout its entire length in a covering of schreibersite and upon one end to within 2.5 cm. from the edge is enveloped in limonite; a second troilite cylinder, 3 cm. thick, has fallen away except for a few traces. The illustration shows the structure very distinctly, the prominent, dark, compact ribs of cohenite being very regularly disposed in the kamacite or absent altogether.

Cohen[7] remarks the occurrence of cohenite in the meteorite and notes[8] that it takes on a more or less strong permanent magnetism.

In the separation of Duel Hill, most later authorities agree with Brezina. Apparently, two falls took place upon the same hill within a mile of each other. One was a fine, the other a coarse, octahedrite. Of the fine octahedrite, there were two masses, probably, since the Amherst specimens are fine octahedrites. A further account of the history of the meteorite is given under Jewell Hill.

Only 1,510 grams of Duel Hill are listed in collections, Vienna possessing the largest piece. As remarked by Cohen,[11] however, the catalogues do not always distinguish between Duel Hill and Jewell Hill.

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East Tennessee, 1840. See Cosby Creek.

East Tennessee, 1853. See Tazewell.

East Tennessee, 1860. See Cleveland.

East Tennessee, 1887. See Morristown.

East Tennessee, 1891. See Jonesboro.

Eau Claire. See Hammond.

Echo. See Salt Lake City.

Eddy County. See Sacramento Mountains.

EAGLE STATION.

Carroll County, Kentucky.
Here also Carroll County.
Latitude 38° 38′ N., longitude 85° W.
Pallasite (P) of Brezina; same (type 26) of Meunier.
Found 1880; described 1887.
Weight, 36.5 kgs. (80 lbs.).

The first description of this meteorite was by Kunz [1] as follows:

This meteorite was found in 1880, about three quarters of a mile from Eagle Station, Carroll County, Kentucky, 10 miles from the mouth of the Kentucky River and about 7 miles in a direct line from both the Kentucky and Ohio rivers.

The mass weighs about 80 pounds (36.5 kg.), is almost square in form, and measures 19 by 22 by 29 cm. The surface is rusted in some places to a depth of 10 or 12 mm., and deep pits, some 2 cm. across, are observed in spots where grains of olivine have dropped out. All of the original crust has disappeared. The mass is largely made up of fine, yellow, transparent olivine, resembling closely that of the famous Pallas iron.

Fragments of meteoric iron found in the Turner Mounds in the Little Miami Valley, Ohio, some 60 miles distant, probably belong to the same fall as the Eagle Station specimen.

The iron in the Carroll County meteorite is scarcely more than sufficient to hold the mass together securely. On etching, small, fine, Widmannstätten figures are produced. By reflected light, minute crystals of bronzite can easily be recognized, and the analysis showed the presence of chromite in fine grains and a very small quantity of schreibersite.

Analyses of the olivine and iron were made by J. B. Mackintosh:

Olivine.		
SiO_2	37.90	39.36
MgO	41.65	(41.83)[a]
FeO	19.66	18.81
MnO, CoO	0.42	.....
	99.63	100.00

Specific gravity=3.47

Metallic portion.			
Fe	73.44	or Fe	71.73
Ni	14.27	Ni	14.27
Co	0.95	Co	0.95
P	0.05	P	0.05
SiO_2	4.23	Olivine	11.12
MgO	4.69	Chromite	0.90
Chromite	0.90		
	98.53		99.02

The balance in the last analysis is oxygen in the form of iron oxide and undetermined constituents. For the pure metallic portion we obtain then *a* below or *b* on the assumption that the deficiency in the analysis is chiefly oxygen combined with iron as magnetic oxide.

	a	*b*
Fe	82.45	81.92
Ni	16.40	16.90
Co	1.09	1.12
P	0.05	0.06
	100.00	100.00

For comparison, analyses of the olivine and iron from the Turner mound and Atacama meteorites are added.

[a] By difference.

While in this paper Kunz expressed the opinion that this meteorite belonged to the same fall with the irons from the Ohio mounds, in a later paper[4] he withdrew this conclusion on account of the structure of Eagle.

Meunier[3] gives a brief account of the study of the meteorite, but elicits no facts of importance. Brezina,[5] in his 1895 catalogue, classes Eagle in the Rokicky group, the characteristics of which are polyhedral olivines broken and separated by movement of the inclosed iron. Of Eagle he remarks that it—

is one of the most beautiful and interesting meteorites in consequence of the freshness of its olivine and the peculiar faulting. The iron borders the olivine generally in the form of complete lamellæ, a strong tænite ribbon lying adjacent to the olivine. The iron in the interior is separated into differently oriented parts by wavelike, bent bands of tænite. No actual trias is visible, but here and there in the interior of the iron appear groups of fine lamellæ like those of Butler.

The meteorite is distributed, but is chiefly (18 kg.) in the Vienna collection.

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EL CAPITAN.

El Capitan Mountains, New Mexico.
Latitude 33° 40′ N., longitude 105° 17′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1893; described 1895.
Weight, 27.5 kgs. (61 lbs.).

This meteorite has been described only by Howell[1] as follows:

This handsome meteorite was found by a Mexican sheep herder, Julian Jesu, in July, 1893, on the northern slope of the El Capitan range of mountains in New Mexico. Three small pieces were broken from the thin edge which show beautifully the octahedral structure of the iron. The smallest of these, weighing a few ounces, was sent to the United States National Museum, and the two larger, weighing respectively 1 pound 12.5 ounces and 3 pounds 14 ounces together with the main mass, 55 pounds, came into my possession at different dates in 1894. The weight of the iron when whole was about 61 pounds; the general shape is shown by cuts. It measured 10 by 9 by 5 inches, thinning at one edge, and had the usual irregular pitted surface. My information in regard to the history of the meteorite, as well as the meteorite itself, was obtained from Mr. C. R. Biederman of Bonito, New Mexico. Mr. Biederman says that he, in company with many miners, was standing in front of a store in Bonito some time in July, 1882, when they saw "a meteorite which looked like a fiery ball moving rapidly toward the south at an angle of 45° which vanished behind the El Capitan range." Mr. Biederman thinks the meteorite found by the Mexican is the one they saw fall, and there is nothing in its appearance to disprove his claim. It is entirely free from oxidation and evidently fell at a comparatively recent date. The Widmannstätten figures are developed very easily and clearly and indicate that it belongs to the usual type of octahedral irons with rather broad bands of kamacite.

Analysis (Stokes):

Fe	Ni	Co	Cu	Si	P	S	
90.51	9.40	0.60	0.05	trace	0.24	trace	=99.80

The meteorite is distributed.

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Eldorado County. See Shingle Springs.

Ellenboro. See Colfax.

ELM CREEK.

Lyon County, Kansas.
Latitude 38° 40′ N., longitude 96° 5′ W.
Stone. Ornansite (CcO), of Brezina.
Found 1906; described 1907.
Weight 7,075 gr. 7 kgs. (15 lbs.).

This meteorite was described by Howard [1] as follows:

Another aerolite from Kansas has just been obtained by Ward's Natural Science Establishment, of Rochester, New York. It is of especial interest as having been found near Admire, Lyon County, where the Admire pallasite was found in 1902.

About May 10, 1906, J. R. Waters ploughed up the meteorite some three miles north-northeast of Admire. It was buried about eight inches deep in a field that up to that time had never been cultivated to any depth. Mr. Waters also says that "it was on a slope where the soil would wash off of it instead of burying it up deeper." The exterior of the stone exhibits considerable oxidation, so that it has evidently lain in the ground for a number of years. There have been so many aerolites found in Kansas that at first there was a question as to whether this one constituted a distinct fall or if it were merely one of a shower. An examination of a polished surface, however, showed that it is entirely different from other Kansas stones.

Elm Creek, a branch of the Marais des Cygnes River, flows about three-fourths of a mile from where the stone was found, and as one meteorite has already been named after Admire this one will be called the Elm Creek aerolite.

Its weight is 7,075 grams. It measures approximately 22 by 19 by 12 centimeters. The stone is highly oriented, the pittings radiating from a point a little below the center. Any markings that may have been on the reverse side have been obliterated by oxidation. The stone is very firm and excepting where a few small chips have scaled off shows no signs of fracture.

Dr. Geo. P. Merrill, of the United States National Museum, has made a microscopic examination of the aerolite and describes it as follows: "The stone on a polished surface is of a dark gray, nearly black color, thickly studded with metallic iron and with numerous indistinct chondrules which break in large part with the groundmass. Under the microscope the silicate portion is found to consist essentially of olivine and enstatite with a twinned monoclinic pyroxene. The olivine occurs in the usual clear, colorless forms quite free from inclosures; in minute fragments and splinters and in chondrules of the barred and porphyritic type common to meteorites. A part of the porphyritic forms show a base of yellowish glass, while others seem holocrystalline. Occasional forms are met with in which the entire chondrule is composed of a single individual, in which case the central portion is clear and colorless, while the borders are of a light smoky-brown color and show a fibrous structure. All portions are, however, optically a unit.

"The enstatites like the olivines occur in scattered fragmental particles and in chondrules, the latter of the common cryptocrystalline and radiate type, and in porphyritic forms. In the latter the crystal outlines are at times very well developed. The cryptocrystalline forms are often remarkably spherical, or at least circular in outline in the section. As such they rarely polarize as a single individual, but as is commonly the case the field breaks up into sectors, as the stage is revolved between crossed Nicols. It is of course possible that not all of these cryptocrystalline forms are of enstatite; some may be of augite or possibly olivine. An optical determination is impossible, and the determination is based on their resemblance to others which have been tested chemically.

"The monoclinic pyroxene is of interest on account of the beautifully developed polysynthetic twinning which it presents when either in chondrules or in fragments in the groundmass. In this respect it would seem to be fully comparable with the meteorite of Renazzo, Italy, as figured by Tschermak on Plate 15 of his Mikroskopische Beschaffenheit der Meteoriten. Crystal outlines are rare and the mineral is a trifle less limpid than the enstatite. A prismatic cleavage is fairly well developed. No feldspars or other silicates than those mentioned were detected.

"The most striking feature of the stone is the spherical perfection of many of the chondrules and the perfection of the twinning in the pyroxene. As a whole the stone is plainly fragmental—is composed of a moderately firm mass of angular fragments in which are embedded the chondrules. I am disposed to class it with those of Allegan, Michigan, San Emigdio, California, and Warrenton, Missouri. This, following Brezina, would throw it in the group of Ornansite (CcO), from which it differs only in its firm character. I confess, however, that I fail to see the necessity of attempting to name rocks according to their degree of compactness or friability."

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Emmett County. See Estherville.

EMMITSBURG.

Frederick County, Maryland.
Latitude 39° 42′ N., longitude 77° 19′ W.
Iron. Medium octahedrite (Om), of Brezina.
Found 1854; described 1885.
Weight (assignable), 177 grams (7 ounces).

Nothing seems to have been published regarding the history of this meteorite. The first mention of it seems to be in the Vienna catalogue of 1885 [1], where it stands as the representative

of the Emmitsburg group of octahedrites with medium lamellæ. The characters of this group given by Brezina [1] are as follows:

Lamellæ straight, grouped, not very long; kamacite dark gray, hatched, in part spotted, with plain though not very strongly oriented sheen. Rhabdite very abundant, at times on the edges of the fields taking the place of tænite. Width of lamellæ 0.6 mm.

In the 1895 catalogue, Brezina [2] remarked that Emmitsburg much resembles Plymouth. No further account of the meteorite seems to have been given. The spelling Emmitsburg, here adopted, is from the United States Postal Guide. Brezina's spelling is Emmetsburg.

The meteorite is distributed among collections, but only 177 grams in all seem to be known, according to Wülfing.[3]

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2. 1895: Brezina. Wiener Sammlung, p. 277.
3. 1897: Wulfing. Die Meteoriten in Sammlungen, p. 113.

ESTACADO.

Hale County, Texas.

Estacado is located in Crosby County, but the place of find was Hale County.

Latitude 33° 50′ N., longitude 101° 45′ W.
Stone. Crystalline chondrite (Cka) of Brezina.
Found 1902; described 1906.
Weight, 290 kgs. (640 lbs.).

This meteorite was described by Howard and Davison [2] as follows:

What is known concerning the fall of this meteorite is told by a resident of Hale Center, Texas: "The best history I can give of the meteorite is as follows: It was found 12 miles south of Hale Center, which is located in the center of Hale County, Texas, in the spring of 1902, or rather that is when it was taken home by R. A. McWhorter, who had been the owner of it all the time. In the year of 1882 a bright meteor was seen one night by the people of a Quaker colony called Estacado. This place is about 15 miles southeast of where the meteor was found. The meteor was seen to pass to the west and fall northwest from them. At that time this Quaker colony was the only settlement on the whole Staked Plains and the only people outside of them were a few scattering cowmen. In the following year of 1883 a few cowboys in rounding up the range saw this meteor, and the Estacado people felt certain that this was what they saw fall the year before, and we have all considered it so." As the region is a stoneless one, the attention of the people of the vicinity was naturally attracted to this remarkable mass. The name of the settlement, Estacado, seems most appropriate for the aerolite.

The weight of the meteorite before sawing was about 290 kg., it thus being among the largest of known aerolites. Its form was trapezoidal. Its longest diameter was 58.5 cm., while its other two diameters measured 45.7 cm. and 44.4 cm. It was cut in half parallel to its longest and shortest diameters. Several slabs were taken off at the same time.

The exterior of the mass is rusty brown in color, probably due to terrestrial oxidation. The sawed slices of the stone show a tendency to rust rapidly. Hardly any of the coating of the meteorite approaches in appearance the black of an original crust. On some of the sides the oxidation has been considerable, a scale knocked off of one side being 3 to 4 mm. thick. The mass has eight well-marked sides, one of which looks like an old fracture surface. The oxidation on this side is less than elsewhere and there is no apparent variation in structure as the edge is approached, such as there is on the other sides. The sides are quite flat, some of them even slightly concave, the edges between adjoining sides being for an aerolite fairly angular.

Side A (shown in cut) has a smoothed appearance and may have been the "nose" of the mass in flight. The surface markings on this side are not deep, while on sides D and E, which are opposite A, there are well-defined pittings.

The stone is a crystalline chondrite, its structure being very similar to the Pipe Creek aerolite, which is also from Texas. In Brezina's classification Pipe Creek is placed in group Cka.

The polished surface shows a dull black groundmass thickly permeated with irregular particles of nickel iron. Roundish enstatite chondri of a more shiny black are scattered through the stone. Here and there are green olivine chondri, some of which are larger than any of the black chondri. The largest of the green ones measures about 1 cm. in length.

The slice also shows some other interesting markings. Some 5 cm. from the center toward the smaller end a straight dark line runs across the meteorite at an inclination of about 15° from the vertical. It passes just to one side of one of the olivine chondrules. Parallel to and 15 cm. from side A (shown in cut) is an irregular and somewhat broken line composed of the metallic particles. This line runs from the edge of side F nearly to the edge of side B.

The line also shows on some of the other slabs, and on one of them just before it reaches the edge of side B it turns and runs parallel with the edge for a couple of centimeters. On the various slabs the metallic lines are at different distances from side A, indicating that a seam of this material passes through the meteorite obliquely to the cut surface.

From the edge of side F, which shows comparatively slight oxidation, three indistinct veins run into the meteorite. They are black, indefinite in outline, and somewhat branching.

A petrological analysis by W. Harold Tomlinson of Germantown, Pennsylvania, shows that the mineral constituents are olivine and enstatite. Some pyrrhotite was also found. Mr. Tomlinson remarks: "The olivine and enstatite occur both as grains and as chondri. The grains of olivine contain frequent inclusions of smaller grains and of iron, and occasionally have gaseous inclusions. The inclusions in the enstatite are generally parallel to the cleavage." He found the specific gravity to be 3.60.

CHEMICAL ANALYSIS BY JOHN M. DAVISON.

The specific gravity of the Estacado aerolite is 3.63. The metallic part was separated with a magnet and the slight amount of adhering stony matter determined and deducted.

The stony part was separated by hydrochloric acid into a soluble and an insoluble portion. The insoluble portion was digested with a solution of Na_2CO_3 and the dissolved SiO_2 added to that dissolved by HCl. This analysis gave:

Metallic		16.41
Stony	Soluble in HCl	41.09
	Insoluble in HCl	42.50
		100.00

Analyses of these, omitting minor constituents and calculated to 100, gave:

Metallic.		Soluble in HCl.		Insoluble in HCl.	
Fe	89.45	SiO_2	32.00	SiO_2	63.57
Ni	9.99	MgO	32.02	MgO	23.45
Co	0.56	FeO	31.60	FeO	9.54
	100.00	CaO	4.38	CaO	3.44
			100.00		100.00

The stony part appears to be mainly olivine and enstatite. The analysis of the entire mass gave the following percentages:

Fe	14.68
Ni	1.60
Co	0.08
Cu	Trace.
C (found but not determined).	
S	1.37
P	0.15
SiO_2	35.82
FeO	15.53
MgO	22.74
CaO	2.99
Al_2O_3	3.60
Na_2O	2.07
K_2O	0.32
TiO_2, Cr_2O_3, and MnO (found but not determined).	
	100.95
Less O for S	.68
	100.27

Of the S found 0.82 per cent came from the metallic and the portion soluble in HCl, and 0.55 per cent from the insoluble portion fused with Na_2CO_3. In this fusion the crucible was screened by a close fitting asbestos board and a blank experiment showed that there was no contamination from the gas flame. This distribution of the S would indicate that nearly half of the troilite was embedded in the enstatite protected from action of acids.

From 3.9597 grams of the aerolite 0.025 gm. of chromite was separated by repeated treatment with HF and other acids. With the chromite were a few minute particles of a transparent colorless mineral that had survived this usage though evidently attacked. Search was made for ZrO_2, with negative result.

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ESTHERVILLE.

Emmet County, Iowa.
Here also Emmet County and the "Perry meteor."
Latitude 43° 25′ N., longitude 94° 50′ W.
Mesosiderite (M), of Brezina; Esthervillite (type 30), of Meunier.
Fell 5 p. m., May 10, 1879; described 1879.
Weight. A shower of many hundred stones. Total known weight 337 kgs. (744 lbs.). The two largest masses weighed 437 and 151 pounds, respectively.

The first mention of this fall was by Peckham,[1] in a letter to the editors of the American Journal of Science, from Minneapolis, published in July, 1879. His account was substantially as follows:

On the 10th of May, 1879, a meteor exploded and fell in full daylight at 5 p. m., at Estherville, Emmet County, Iowa. One of the fragments, weighing about 500 pounds, fell on railroad land and was dug up from a depth of about 14 feet in a stiff clay soil. Another smaller portion, weighing about 170 pounds, fell on the farm of A. A. Pingrey, at a distance of 2 miles from the first. Many smaller pieces of a few ounces or pounds weight were scattered in the vicinity. The smaller mass fell upon a dry knoll and penetrated the earth vertically to a depth of 4.5 feet. The fall was accompanied by a noise described as a continuous roll of thunder accompanied by a crackling sound.

The metallic portion is composed of an alloy of iron, nickel, and tin. Full half the mass consists of stony matter, which appears in dark-green crystalline masses embedded in a light gray matrix. Some of the crystalline masses are 2 inches in thickness, and exhibit distinct monoclinic cleavage. Under the microscope, in thin sections, olivine and a triclinic feldspar appear to be embedded in a matrix of pyroxene. A small polished surface exhibited the Widmannstätten figures very finely by etching.

The larger mass is still in the hands of those who dug it from the ground, although their ownership is contested by one who claims to have contracted for the land on which it fell. Their ideas of its value enlarge daily, the latest announcement being that they should feel insulted at an offer of $5,000. We trust their feelings may be spared.

The smaller mass referred to by Peckham, he states was acquired by the University of Minnesota. It is described as being square in form and 15 by 18 by 6 inches in dimension.

Two months later a more complete account was published by Shepard,[2] of which the following is a nearly complete abstract:

Messrs. S. E. Bemis, Howard Graves, and Henry Barber, of Estherville, are authority for the following account of the fall of this meteorite:

The fall occurred at 5 p. m. on May 10, 1879, attended by a terrible explosion, resembling the discharge of a cannon, only louder. It seemed to proceed from a region high up in the air, and was followed by a second report, more like a heavy blast. This again was succeeded by one or two more reports, that may have been echoes of the first two. Nearly a minute after, a rumbling sound was heard, apparently passing from the northeast to the southwest. The sky was clear at the time, or only a few fleecy clouds were visible. An observer, Mr. Charles Ega, looking in the direction of the report, could see nothing on account of the sun's rays; but following with his eye the direction of the roaring sound that succeeded, he saw dirt thrown high into the air at the edge of a ravine, 100 rods from the place where he was standing. At a like distance still farther in the same direction, a similar disturbance of the ground was seen by Mr. Barber. Another witness, Mr. S. W. Brown, living three-quarters of a mile distant, being in the edge of a wood, and having his eyes directed upward at the moment for the inspection of some oak trees, saw a red streak in the heavens; and while looking at it, the explosion took place. It appeared to him that the meteor was passing from west to east, and that when it burst there was a cloud at the head of the red streak which darted out of it like smoke from a cannon's mouth and then expanded in every direction.

On examining the ravine where a body was seen to strike, a hole in the ground was discovered, 12 feet in diameter and 6 in depth. It was filled with water. Within this hole, at a depth of 14 feet below the general surface of the ground, the large mass, weighing 431 pounds, was found. It had penetrated a stratum of blue clay to the depth of 6 feet before its progress had been arrested. The mass measured 27 by 22.75 by 15 inches. Its surface is described as "fearfully rough," with ragged projections of metal. From one of these a portion was detached and shaped into a finger ring. After much searching there have since been found in the immediate vicinity of the hole several smaller masses, varying in weight from 1 to 8 ounces; also one mass of 4 pounds and another of 32.

At the distance of 2 miles from this spot, in a westerly direction, a mass of 151 pounds was also discovered. It was embedded in a dry gravelly soil at the depth of 4.5 feet.

It is marked by the unusual prevalence of chrysolite and meteoric iron, the former probably constituting two-thirds of its bulk; also by the size and distinctness of the chrysolitic individuals, together with their pretty uniform, yellowish-gray or greenish-black color, and by the ramose or branching structure of the meteoric iron. Nearly one-half of the chrysolite, however, is more massive, approaching fine granular, or compact. Yet, in this condition it is still highly crystalline, and with difficulty frangible. This portion is of an ash gray, flecked with specks of a dull greenish-yellow color. The luster is feebly shining. It is without any traces of decomposition; on the contrary, it is throughout a fresh, undecomposed crystalline aggregate. It is especially observable that the stony portions nowhere present traces of the oolitic or semiporphyritic structure, so common in meteoric stones.

The crust is of the usual thickness, black, without luster, and much wrinkled. One of the fragments shows a cavity of half an inch area completely lined with a shining dark-green glass, as if from perfect fusion of chrysolite.

The meteoric iron, besides being in ramose branches, is also in enveloping coatings around the chrysolite, somewhat as in the Pallas and Atacama irons. The presence of schreibersite in the metal is apparent to the naked eye; also traces of the Widmannstätten figures which so constantly attend its presence, and to which they owe their production.

A very remarkable appearance is exhibited by the meteoric iron in some specimens. It is the bright silvery whiteness of the metal where it forms a portion of the exterior of the stone. It appears to have been fused and is surrounded on all sides by the black crust coming from the stony material.

Chrysolite occurs in large distinct concretions, some of which show imperfect crystalline facets, and nearly all the larger ones possess eminent cleavages. In a few instances they are transparent and gemlike.

Troilite, in distinct individuals, sometimes as large as a pea is highly crystalline, rarely presenting splendent crystalline facets, whose color approaches silver white. The proportion in which it exists is apparently large, and may equal 2 per cent.

A feldspathic mineral, presumably anorthite, is highly crystalline, white, lustrous, and nearly transparent, resembling the similar material found among the jecta of Vesuvius.

Specimens of an opallike mineral of a yellowish brown color, probably chassignite, and chromite occur.

It differs widely from the normal meteoric stones, in the unusual prevalence of a chrysolite similar to that found in the meteoric irons; in the large proportion of meteoric iron present; and in the fresh and highly crystalline condition of all the constituents. Nothing like an aggregation of pulverulent, ashlike grains, more or less rolled into oolitic shapes, so common in meteoric stones, is descernible. The stony portions resemble much more the olivinic rocks of extinct volcanoes, particularly those of the Eifel district.

Judging from the specimens in hand, it can not properly be referred to any group of meteoric stones with which we are acquainted. It would rather appear to be a connecting link between the litholites and the lithosiderites, though it may possibly find a place in the Eucritic group of the former, in which case it would form an order by itself.

An elaborate study of the meteorite was made by J. Lawrence Smith [4] and published about a year after Shepard's account. Smith's account was essentially as follows:

The place of fall is near Estherville, Emmet County, Iowa, just on the boundary of the State of Minnesota, latitude 43° 30′, longitude 94° 50′, within that region of the United States which has become remarkable for meteoric falls.

The fall occurred about 5 o'clock in the afternoon, under a clear sky, with the sun shining brightly. The accompanying phenomena were of the usual character but on a grander scale. In some places the meteor was plainly visible in its passage through the air and looked like a ball of fire with a long train of vapor or cloud of fire behind it, and one observer saw it 100 miles from where it fell. The sounds produced in its course are described as "terrible" and "indescribable," as scaring cattle and terrifying people over an area many miles in diameter. At first they were louder than that of the largest artillery; these were followed by a rumbling noise as of a train of cars crossing a bridge. The concussion when it struck the ground was sensible to many persons. There were distinctly two explosions. The first took place at a considerable height in the atmosphere and several large fragments were projected to different points over an area of 4 square miles, the largest mass going farthest to the east. Another explosion occurred just before reaching the ground and this accounts for the small fragments found near the largest mass.

A remarkable fact connected with the fall, besides the concussion which was sensible to many persons and the throwing up of the ground around the place where it struck, is the depth to which the mass penetrated. Had the fall taken place at night it is doubtful whether the largest mass would have been found. It struck within 200 feet of a dwelling house at a spot where there was a hole (previously made) 6 feet deep and over 12 feet in diameter, filled with water and having a bottom of stiff clay. This clay was excavated to a depth of 8 feet before the meteorite was discovered and two or three days elapsed before it was reached. Its total depth below the general surface of the ground was therefore 14 feet.

The second large mass was found embedded in blue clay 2 miles distant from the first. The third of the three largest masses was not discovered until February 23, 1880, more than nine months after the fall, and its locality was 4 miles from the first. A trapper on the prairies who had witnessed the original occurrence observed a hole in a dried-up slough; on sounding it with his rat spear he detected a hard body at the bottom, and on digging found the stone at a depth of 5 feet. Some small fragments were doubtless detached when the large mass approached the ground, as they were discovered near to it. The fragments thus obtained weighed, respectively, 437, 170, 92.5, 28, 10.5, 4, and 2 pounds.

A railroad engineer who observed it before the report estimated its height to be 40 miles, but at the time of the explosion much less; from an imperfect computation he considered its velocity to be from 2 to 4 miles per second.

The masses are rough and knotted like large mulberry calculi, with rounded protuberances projecting from the surface on every side; the black coating is not uniform, being most marked between the projections. These projections sometimes have a bright metallic surface, showing them to consist of nodules of iron, and they also contain large lumps of an olive-green mineral having a distinct and easy cleavage, which is more distinct when the surface has been broken. The greater portion of the stony material is of a gray color, with this green mineral irregularly disseminated through it. The two minerals are mixed under various forms; sometimes the green mineral is in small, rounded particles intimately mingled with the gray; at other times it is in small cavities in minute crystalline fragments without any distinct faces

and almost colorless. The masses are quite heavy and vary much in specific gravity in different parts, but the average can not be less than 4.5.

When broken one is immediately struck with the large *nodules* of metal among the gray and green stony substances, some of which will weigh 100 grams or more. In this respect this meteorite is unique, differing entirely from the mixed meteorites of Pallas, Atacama, etc., or the known meteoric stones rich in iron, for in none of these has the iron this nodular character.

Another striking feature in the relation of the iron and stony matter is that the larger nodules of iron seem to have shrunk away from the matrix, an elongated fissure of from 1 to 3 mm. sometimes intervening, separating the matrix and nodules to the extent of one-half the circumference of the latter and appearing as if the iron had contracted from the stony matrix during the process of cooling. There are numerous small cavities of various sizes where there are no iron nodules, and where the minerals appear more crystalline, indicating an irregular shrinkage during the consolidation.

At first sight I expected to find more than two earthy minerals. The microscope gave, as with most meteoric stones, unsatisfactory results.

I therefore tried to separate the stony materials mechanically; the only mineral that I was enabled to obtain pure in sufficient quantity has an olive-green color and occurs in masses of from one-half to 1 inch in size, having an easy cleavage, especially in one direction; this proved to be olivine. The same mineral occurs also in minute rounded concretions in other parts of the meteorite, and minute, almost colorless, crystalline particles in the cavities I take to be olivine. Nickeliferous iron, as already stated, is very abundant. Troilite exists in small quantity. Chromite was also found.

That the stony part of this meteorite consists essentially of bronzite and olivine will be seen from the chemical investigation, which found only three essential constituents, viz, silica, ferrous oxide, and magnesia. Another silicate will be referred to beyond, consisting of the same oxides but in different proportions from either bronzite or olivine.

Chemical constitution.—The stony part, pulverized and freed as far as possible from metallic iron by the aid of the magnet, when treated with hydrochloric acid on a water bath for several hours, is resolved into soluble and insoluble parts, the proportions varying very much with different fragments and ranging from 16 to 60 per cent for the soluble part. This soluble part consists of silica, ferrous oxide, and magnesia, and without a trace of lime, thus indicating the absence of anorthite.

1. *Insoluble portion.*—The insoluble portion was carefully analyzed by fusion with carbonate of soda and found to contain:

		Oxygen ratio.
Silica	54.12	29.120
Ferrous oxide	21.05	4.670
Chromic oxide	trace	.....
Magnesia	24.50	9.800
Soda with traces of potash and lithia	.09	.023
Alumina	.03	.013
	99.29	

The oxygen ratio clearly indicates the mineral to be $\breve{S}i\dot{R}$, being virtually $\breve{S}i(\dot{M}g\dot{F}e)$, or the common form of bronzite contained in meteorites.

2. *Soluble portion.*—On testing the green mineral already referred to I found that this was the soluble portion, and it was readily detected in a pure state from the stony part of the meteorite. Its cleavage in one direction is very perfect; its specific gravity 3.35; hardness about 7; pulverized it is readily and completely decomposed by hydrochloric acid. Two analyses were made, one by decomposing it directly with hydrochloric acid over a water bath and the other by first fusing it with carbonate of soda, the two analyses agreeing perfectly.

		Oxygen ratio.
Silica	41.50	22.13
Ferrous oxide	14.21	3.12
Magnesia	44.64	17.86
	100.35	

The above analysis gives the formula $\breve{S}i\dot{R}_2$, or that of olivine.

3. *Opalescent silicate.*—In some parts of this meteorite a silicate occurs that is opalescent, of a light greenish-yellow color, and cleaves readily. In one instance I observed it making a notable projection on the surface. Although I had a number of fragments of the meteorite for examination, amounting to 10 or 12 pounds, I did not obtain enough of the mineral to establish positively its true character, but I hope to obtain more. An analysis was made with about 100 mg. of the pure mineral with the following result:

		Oxygen ratio.
Silica	49.60	26.12
Ferrous oxide	15.78	3.50
Magnesia	33.01	13.21
	98.39	

Equivalent to $\dot{S}i\dot{R}_2+\breve{S}i_2\dot{R}$, one atom of bronzite plus one atom of olivine, a form of silicate that we might expect to find in meteorites.

4. *The nickeliferous iron.*—As already stated this iron is abundant in meteorite, and sometimes in large nodules of 50 to 100 grams; on a polished surface the Widmannstätten figures are beautifully developed by acid. On analysis it was found to contain:

Iron	92.001
Nickel	7.100
Cobalt	.690
Copper, minute quantity.	
Phosphorus	.112
	99.903

5. *Troilite.*—The proportion of troilite is not large and it could be detached only in small fragments.

6. *Chromite.*—When small pulverulent fragments of the meteorite are heated with hydrochloric acid for some time and the residual matter washed and dried it is easy to find particles of the stony mineral more or less filled with minute, black, shining particles which are chromite.

The constitution of this meteorite, so far as I have been able to make it out, is therefore as follows: Bronzite, abundant; olivine, abundant; nickeliferous iron, abundant; troilite, in moderate quantity; chromite, in minute quantity; silicate, not yet well determined.

It will be thus seen that in its composition the meteorite contains nothing that is peculiar. I should, however, give it a unique position among meteorites, on account of the phenomena accompanying its fall, especially the great depth to which it penetrated beneath the surface, and also because of its physical characters and the manner of association of its mineral constituents. I examined carefully for feldspar and schreibersite; but the absence of both lime and alumina (except as a trace) clearly proved the absence of anorthite; and the small particles of the mineral that might have been taken for schreibersite were found on examination in all instances to be troilite.

In the same volume but in a later issue Smith [4] reported the finding of additional masses, as follows:

A number of boys, herding cattle near a lake about 4 miles west of Estherville on the day of the fall, reported that when the meteor passed over them, a great shower of what appeared to them hailstones fell, and that the surface of the water was alive with the falling bodies. Nearly a year after the fall, or about April 15, 1880, the people of that region began to find on the freshly burned prairies small pieces of meteorites, from the size of a pea to 1 pound in weight; 300 to 500 were thus found; and 10 days later (about May 1, 1880), thousands of men, women, and children were on the ground daily, and from the meteoric field probably 5,000 pieces have been already gathered, making not less than 60 to 75 pounds in all.

This statement was repeated in the next volume of the American Journal of Science and some additional observations made as follows:[5]

This lake was near the border of Dickinson County (the county west of Emmet) and about 5 or 6 miles southwest from where the larger masses fell. All the smaller pieces are little lumps of nickeliferous iron, and even the larger ones have but little stony material attached. These lumps of iron were on the wet prairie for nearly one year, and yet they were not in the least rusted, many parts being bright, some looking like nuggets of platinum. It may be that they are protected by an invisible coat of melted silicate.

It is clear that the rapid passage of the meteorite through the air disintegrated the surface very rapidly, pulverizing the stony part completely; and the nodules of iron not undergoing this disintegration fell in the track of the meteorite for many miles, and the greater number of them will never be found.

This last discovery helps to fix more positively the direction of the meteorite. In former descriptions its course is given as from northwest to southeast. But its general direction was from south-of-west to north-of-east; the meteorite came from south of an easterly course in Dickinson County, and going north of that line in Emmet County dropped the smaller fragments over the surface of the latter.

In this last statement Smith seems to be in error. From his own showing, he should have said larger fragments over the surface of the latter, i. e. Emmet County, instead of smaller.

In the same paper, Smith [5] gives a further description of what is evidently the "opalescent silicate," referred to by him in a previous paper. This he considers to be a new mineral and gives it the name "peckhamite."

He states that having been furnished with additional material he is enabled to make a more positive determination of the distinctive characters of the mineral, which he regards as decidedly different from any mineral he has seen associated with meteorites.

In two or three specimens it projected above the outer surface, having a dingy yellow color and a fused surface. When broken it has a greasy aspect with a more or less perfect cleavage, and the yellow color has a greenish hue. Its structure differs widely from olivine, as may be seen under the microscope. Small rounded nodules, several milimeters in size, are found in the interior of the mass, sometimes of irregular form, from which fragments nearly pure can be detached.

Chemical analyses from two specimens gave:

	No. 1.	No. 2.	Oxygen ratio from No. 2.
Silica	49.50	49.59	25.73
Ferrous oxide	15.88	17.01	3.77
Magnesia	33.01	32.51	12.76
	98.29	99.11	

The oxygen ratios indicate a compound of two atoms of enstatite or bronzite plus one atom of olivine.

These small fragments (of Estherville meteorite) in the differences of composition and specific gravity, show a hitherto unheard of phenomenon of meteorites of one and the same fall. One of these small masses, for instance, consists almost exclusively of iron, with a specific gravity of 7 to 7.3; others are almost free of iron and consist of a granular crystalline mass of olivine, with a specific gravity of 4 to 3. Between these extremes are all variations. The mean specific gravity of 14 specimens is 5.80 and this may be the weight of the larger masses.

According to Shepard, the small aerolites, with their differing specific gravities, do not originate from the breaking up of larger bodies by its entrance into the earth's atmosphere, but are independent parts of the swarm. While the pieces of iron are of very irregular, sometimes of jagged form, Shepard describes a small stone with a specific gravity of 3 as a flattened spheroid with distinct Brust and Ruckenseite and also lines of flow which, directed from apex to periphery, indicate the direction of flight.

Vom Rath [6] gives the following account of the meteorite:

On account of its mineralogical constitution, the Estherville fall possesses great interest. The stones are of an unusual kind; that is, they are not chondrites. They are further remarkable for the highly granular, crystalline structure and the absence of chondritic spheres. The crystalline grains (olivine) are of extremely various sizes. Besides grains of 1 cm. in size, distinguished by their cleavability, there are others of less than a milimeter in size. The structure is also noteworthy from the fact that hollow spaces and swellings, so exceedingly rare in meteorites, are present, upon whose walls individual very small crystals are to be seen. As olivine forms the largely predominant constituent of two samples almost entirely free of iron, so it appears also in many-sided crystals in the small hollow places. In a granule of about 0.5 mm. in size, rounded like the pallas-olivine, there may be two zones crossed in one face. Besides the olivine, there is also present, as a more subordinate constituent, an almost colorless mineral of a glassy luster, which also occasionally shows crystalline faces. Shepard regards this colorless constituent as a triclinic feldspar, anorthite, an explanation which, however, does not seem free from doubt. According to Shepard, chromite is also present in extremely small quantities. Finally troilite is still to be mentioned as a constituent of the Estherville meteorite. Although the small aerolites of the Estherville fall, so strikingly different in respect to the predominance of olivine on the one hand, and of iron on the other hand, are not to be regarded as fragments of a much larger mass broken up by entrance into the earth's atmosphere, we must still regard both as constituents of meteoric phenomena; as also the larger lumps inclosed in predominant olivine masses are unevenly distributed and irregularly formed iron masses. It is not easy, as Shepard has pointed out, to refer this meteorite to any division hitherto established. If we consider the stones as made up essentially of olivine, the meteorite of Chassigny, which is regarded as the type of a special class, would furnish the nearest comparison, while the masses rich in iron appear to connect themselves with the pallasites.

Brezina,[8] in 1881, made brief mention of the meteorite as follows:

Specific gravity of stony portion, 3.36; of metallic portion, 5.97.

The Estherville stone shows a very beautiful and peculiar crust, although corresponding to the coarse-grained structure in extremely various forms, according as they inclose troilite or the bronzelike groundmass of the iron. The small quantity of peckhamite present does not at all suffice to distinguish this stone from the other mesosiderites.

Meunier [9] reports his conclusions from a study of the meteorite, as follows:

In classifying the specimens from this fall, it occurred to me to see whether the rock of which they are composed is new to science or whether it belongs in some of the numerous lithological types already established.

The result of my researches, very different from what might be inferred from those of Lawrence Smith, is that the meteorite of Emmet County belongs lithologically to the type which since 1870 I have called by the name of logronite, the best-known example of which is procured from the masses of the Sierra de Chaco (Bolivia). It is known, moreover, that the fall of logronite was already witnessed at Barea, near to Logrono (Spain), on July 4, 1842.

At first sight the Estherville rock appears to differ distinctly from the logronite type. It is not so dark, and the granules of iron disseminated through it present on the whole a more considerable volume. The result of this latter characteristic is that the mass makes the impression of a pure polysiderite; but upon closer inspection it is possible to discover that with the more or less globular grains of iron are associated thin metallic filaments which bind the whole together and constitute at many points the true cement of the stony elements. This characteristic appears also in the meteorites of Sierra de Chaco and Logrono, which are as much syssiderites as sporadosiderites.

As to the lighter shade of the Emmet County specimen, in comparison with Logrono and Sierra de Chaco, it may be due to certain coloring matters, infiltrated into these latter, which had not time to originate in equal proportion in the more recently fallen stone. These coloring matters are probably derived, by oxidation, from certain elements of

the rock. In thin sections, Emmet County, Logrono, and Sierra de Chaco give the same results, with this peculiarity, consequent upon the former, that the transparency of the rock is the less the longer the time since its fall.

The principal minerals in the Emmet County meteorite are:

Olivine in very large crystalline masses, showing in polarized light the most brilliant mosaic colorings. In natural light they are colorless, often cloven, and filled with crystalline inclusions. Liquid bubbles, remarkable for their large size, may also be seen in the spheroidal cavities. In converging light the crystals give two systems of very brilliant rings whose axes are very remote.

Bronzite, in crystals poorly terminated, distinctly dichroitic, often presenting rectilinear cleavages parallel to one another and very distinct.

A mineral in large crystals slightly colored and having a contrary effect upon polarized light. The action of acids upon them would indicate that they result from the union of alternate laminæ of extremely thin bronzite and olivine, and this supposition may perhaps account for the analysis, published by Smith, of a mineral which he calls peckhamite and which he found in the Estherville meteorite. A small fragment of peckhamite in the Museum at Paris shows the characteristics of the new mineral; and a grayish grain, embedded in the specimen 2Q.414 of the Sierra de Chaco meteorite, appears to be identical with this peckhamite. This is another link between the Estherville and Sierra de Chaco meteorites.

Pyrrhotine, a grain of which shows several faces of the prism.

Schreibersite, the presence of which is established in the Estherville mass and which shines with a lively luster in the residuum left by the action of acid upon the rock.

Iron oxide in very distinct octahedrons.

Nickel-iron.

It is known that besides the large masses, the fall of May 19, 1879, furnished an abundance of quite complete small meteorites. They differ very much among themselves; some are almost entirely metallic and present a structure resembling that of the syssiderites of the Rittersgrün group. The iron is malleable and yields beautiful etching figures; 8 per cent of nickel has been found in it. Other complete specimens are both metallic and stony. The iron sometimes constitutes an extremely fine network, quite comparable to that of the meteorite of Lodran.

In view of these various characteristics of composition and structure, it is evident that the identity of this specimen with the logronite already described is complete. We may suppose, in regard to Estherville, that the original mass was in a fragmentary state, partly stony, partly metallic, perhaps accumulated in a crevice, and was there subjected to metalliferous emanations whose product, in the form of a fine network, cemented these independent elements. The remarkable cavities sometimes occurring between the grains of iron and their stony matrices have been artificially reproduced in experiments on the metallic cementation of the powder of peridot by a process previously described.

Tschermak [11] gave a study of the optical characters, as follows:

The meteorite of Estherville, which brought to the earth many small and some large individuals, may be included among the mesosiderites. Many of the small pieces are composed wholly of iron, others of silicates, the remainder have both. In the larger individuals both occur. If all the masses were united into one, a coarse, irregular mixture of iron and granular silicates would be formed. According to Smith the iron also occurs in the form of nodules among the silicates. * * * In thin sections a green, granular mass is seen, except for the large crystals of olivine, in which, as groundmass, occurs fine granular olivine with many inclusions in which are suspended crystals and grains of bronzite. The bronzite has in part the usual appearance and contains few inclusions, and in part is clouded by fine dust and shows in addition larger glass inclusions. These turbid grains have megascopically an unusual appearance. They have a greasy luster and by the clouding appear brighter than the other constituents. Smith investigated these grains specially and found their composition one of two-thirds bronzite and one-third olivine. He regarded them a special substance to which he gave the name peckhamite. Through the kindness of N. H. Winchell, in Minneapolis, I obtained a specimen of the silicate mixture with some of the lustrous grains, also a large grain of peckhamite. The latter showed the prismatic cleavage of bronzite, but gave also cleavages which could be referred to the crystal faces of olivine. The optical characters were almost similar to those of bronzite. A section parallel to a prismatic cleavage gave the appearance shown. The whole section is clouded by a fine dust and also contains larger inclusions of two kinds. One variety is in the form of dark-brown to black spheres, the other rodlike or spindlelike light-colored glass inclusions which correspond to negative crystals and similarly colored round glass inclusions. A glance suffices to show that the substance is a mixture, and the analysis does not give a result which corresponds to a simple mineral. Since the turbid bronzite in the silicate aggregate shows the same characters as the above-described peckhamite, and since all gradations occur from pure bronzite to peckhamite, I consider this a bronzite which has been rendered turbid and of greasy luster by a great quantity of inclusions. In many places, in sections, one may recognize colorless, transparent crystals and groups of plagioclase which exhibit broad twinning lamellæ, now free from inclusions, now again containing crystallized inclusions like the mass of Sierra de Chaco, and now rendered turbid by many small, round glass inclusions. A figure shows plagioclase intergrown with olivine and bronzite. Troilite and chromite occur in grains everywhere in the silicates.

It will be seen from the above that Tschermak does not regard Smith's peckhamite as a separate species, and this opinion has been generally concurred in.

A careful study of the meteorite was made by Wadsworth [12] as follows:

This is a peridotite consisting of a grayish granular groundmass, holding irregular grains of olivine and diallage. The olivine grains are of various sizes from very minute ones to those of two inches in diameter. Scattered through the mass in irregular nodular jagged forms, occurs iron. Some bluish-gray fragments were seen inclosed but of an unknown nature, although they may be olivine. The groundmass is identical in appearance with that of the finer grained peridotites and, excepting the iron, the rock is strikingly similar to some from North Carolina.

Two or three patches composed of yellowish-green olivine and a glassy white mineral were seen. The latter resembles feldspar or quartz, but it would probably not be found in the section or by chemical analysis unless especial portions were taken for examination. The iron shows imperfect dodecahedral forms with striated faces. One imperfect form resembled a cube face modified by two pentagonal dodecahedral planes. A few small black grains were seen resembling picotite or chromite. The crust in some places shows that it was derived from the fused olivine; hence if the fusion point of this olivine could be ascertained it would give the minimum temperature of the surface during its passage through the air. The specimen above described, in the Harvard College cabinet, is said to weigh 28 pounds, and it affords, on account of the large extent of its fractured surface, a good opportunity to study the microscopic characteristics of this peridotite. This specimen in some places shows the remains of an internal cavernous structure, its cell walls being lined with minute crystals.

Section: A grayish groundmass, holding grains of enstatite, olivine, and diallage, with iron and pyrrhotite. The groundmass is composed of a crystalline granular aggregate of these minerals.

The olivine is in clear rounded grains of irregular outline. Lying in the olivine are numerous grains and irregular masses of iron which are usually confined to certain portions of the mineral and are wanting in some crystals. Besides the larger, easily recognizable, irregular, semispongelike masses of iron, surrounding, projecting into, or included in the olivine, droplike forms are seen extending in irregular lines from points on the larger iron masses through silicate. These globules are of every size, from those whose metallic luster and character can be readily recognized with low powers to those remaining a fine dust when magnified a thousand diameters. It can not be said that the finer, dustlike portions, resembling the globules in the basaltic base, are the same as the larger globules of iron; but the gradual transition in size between the grains of different sizes, and, with the increase of power, the increase in number of globules that can be recognized as metallic iron leads one to suspect that all these granules, whatever may be their size, are of the same origin and material—iron. These forms, in the minute state, are similar to those of the inclusions in the olivine of the Cumberland pallasite, but in the latter case the iron, if occurring, would be oxidized. Some of the olivine grains show a fine cleavage adjacent to the cross fissures.

The enstatite is in irregular and oval masses, with a perfect longitudinal cleavage and a cross fracture. The extinction takes place in polarized light parallel to the cleavage. The enstatite contains inclusions of olivine and of iron, the same as previously described in the olivine.

The diallage has an irregular longitudinal cleavage, its forms being the same as those of the enstatite. The cleavage lines of the diallage are either cut by irregular cross fractures, or connect by oblique fissures, so as to give an irregular net work over the face, rendering it more obscure and cloudy. The extinction is oblique to the principal cleavage planes. It contains the same inclusions as the enstatite. While the olivine, enstatite, and diallage are all clear, transparent, and colorless in the thin section, yet their cleavage characters are so distinct that in general they can readily be distinguished from one another without the use of polarized light.

The iron and pyrrhotite are in detached granules, droplets, irregular jagged masses, and in imperfect spongelike forms. In some cases they form an irregular network in the groundmass, and in an imperfect ring surround the larger grains of olivine, enstatite, and diallage. The material for the above-described sections was purchased from W. J. Knowlton of Boston.

A figure represents a central crystal of diallage with the surrounding mass of olivine, enstatite, diallage, iron, pyrrhotite, and the ferruginous staining.

Another figure shows the semispongelike mass of iron and pyrrhotite with their inclosed silicates, forming a groundmass holding two porphyritic crystals of diallage and enstatite, showing their characteristic cleavages and inclusions, although the latter are imperfectly represented.

Doctor Smith's chemical analysis was made in such a manner that it is impossible from it to draw any conclusion as to the relative proportion of the elements in the mass as a whole.

I can find no evidence in the sections that its materials ever held any other relation than the present one, and no sign of a former fragmental state; but I do see evidence that is convincing to me that the entire mass has been formed by contemporaneous crystallization, i. e., it has the same structure that a terrestrial lava of the same composition, cooling under conditions that would allow the entire mass to crystalize, would have. The inclusion of the iron in the silicates, indicating their later solidification, would show that the iron was not a posterior emanation. Such a formation as Meunier supposes could not take place without leaving a record behind of its action.

The sections obtained from Prof. C. W. Hall, of the University of Minnesota, who was expected to publish a complete microscopic description, are, in their general and mineralogical characters, so unlike those already described, that, were it not for the source from which they were obtained, it would be very difficult to believe that they came from the same meteorite.

They have a confused light-greenish-yellow groundmass, holding irregular masses of olivine, enstatite, and feldspar. The groundmass appears to be composed of olivine, enstatite, feldspar, pyrrhotite, and magnetite. But little native

iron is to be found in the sections. The groundmass is stained a ferruginous yellow in many places, and the commencement of a serpentine alteration was observed in some of the olivines.

The feldspar is in irregular glassy masses and in imperfect crystals showing striation and extinction oblique to the nicol diagonal. They contain inclusions apparently of olivine, enstatite, magnetite, bubble-bearing glass cavities, etc.

The olivine and enstatite also contain glass inclusions, magnetite, etc. The enstatite in some places is dichroic along its cleavage planes owing to its slight greenish alteration.

These sections having been prepared by a student are of such thickness and ground with so uneven a surface that the study of them is very difficult. A few grains resemble quartz but they are probably unstriated glassy feldspar.

From the various descriptions given it is to be concluded that the Estherville peridotite varies considerably in its mass in different portions—from those parts entirely iron, those of a spongelike iron mass holding silicates, those of but little iron with the silicates, and those that are pure or nearly pure silicates. If detached portions should be taken and analyzed chemically and microscopically it could be claimed that this meteorite is a siderolite, a pallasite, a peridotite, and all be equally correct so far as the portion examined would show; but studying this meteorite as a whole its proper place, both chemically and microscopically, appears to be with the peridotites. The variations in the descriptions given by the different observers who have examined this meteorite are doubtless owing, in many cases, to the actual variation in the rock itself. It offers a striking illustration of the need of some more general method than a purely mineralogical one in the naming of rocks.

Since the preceding was written specimens of this meteorite containing peckhamite have been received from Professor Peckham.

These later sections obtained from Professor Peckham (containing peckhamite) present for the mass of the meteorite the same composition and structure as those obtained from Professor Hall. The peckhamite presents the optical characters and cleavage of enstatite but is filled entirely full of vapor cavities, iron, glass, brown grains, etc. To these inclusions is apparently owing the coloid appearance of peckhamite and the variation in its analysis; while Meunier probably mistook plagioclase for this mineral.

Meunier,[17] in his revision of the lithosiderites in 1895, makes the following further observations:

Thin slices examined under the microscope show large crystals of peridot, poorly defined, full of cracks, very active in polarized light and containing various inclusions. These crystals, evidently worn upon the surface, rounded and cracked, are buried in a crystalline magma, very thin where it is marked by elongated grains of pyroxene, small crystals of triclinic feldspar, and numerous opaque granules, which by special effort I was able to recognize as oxidized iron, more or less chromiferous.

Brezina[18] in 1895, also reported further, as follows:

A lady's finger ring made from the iron of this mesosiderite was procured for the Vienna Museum with the Kunz collection. A nodule, rich in iron, cut in two, showed upon the etched surface grains of iron surrounded by grains of troilite and covered with fine Widmannstätten figures. One of these inclosed a retort-shaped troilite concretion. Another Estherville section showed a fresh brown olivine crystal 1.5 to 2.5 cm. in size with perfect cleavage.

The meteorite is pretty well distributed among collections. London possesses 117 kgs., Minneapolis the 151-pound mass., Paris 50 kgs., Yale 48 kgs., Harvard 18 kgs., and Vienna 23 kgs. Torrey and Barbour[16] state that 500 pounds (presumably including the 437-pound mass) were sent to the British Museum and subsequently divided between London, Paris, and Vienna.

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Fairfield County. See Weston.

FARMINGTON.

Washington County, Kansas.
Here also Washington.
Latitude 39° 58′ N., longitude 97° 15′ W.
Stone. Black chondrite (Cs), of Brezina; Tadjerite (type 41), of Meunier.
Fell 12.45 p. m., June 25, 1890; described 1890.
Weight, 90 kgs. (197 lbs.).

This meteorite was first described by Snow [1] as follows:

Having seen press dispatches from Washington, the county seat of Washington County, Kansas, announcing the fall of an aerolite near that town on Wednesday, June 25, I visited that county at the earliest possible opportunity for the purpose of ascertaining the facts. I found them to be as follows, and verified by a multitude of witnesses. At about 10 minutes before 1 o'clock on the afternoon of June 25, the sky being free from clouds, a strange noise was heard by thousands of people residing in the counties of Washington, Republic, Cloud, Clay, Riley, Pottawatomie, and Marshall, in Kansas, and in the counties of Thayer, Jefferson, and Gage, in Nebraska. The same noise was heard by hundreds of people in counties more distant than those mentioned.

The descriptions given me of the character of this strange sound were exceedingly various. Mr. E. F. Woodruff, of Clifton, fully 25 miles from the place where the meteor struck the ground, stated to me, that while standing on the front porch of his hotel after dinner, a few minutes before 1 o'clock, his attention was attracted to a rumbling like thunder, which began gently, and increased in power to a maximum, rising even above the din of a Missouri Pacific Railroad train which passed within a few rods during the continuance of the phenomenon. The sound appeared to him to come from the zenith, and to continue for two or three minutes, gradually fading away, and being at no time of an explosive character. Mr. John Yates, of Grant Township, more than 50 miles from Washington, on the contrary, heard the sound of the flying meteor, and described it as like the report of a hundred-pound cannon, which shook his house and jarred the windows. He at first supposed the disturbance to be produced by the explosion of a boiler at Gann's elevator, in the neighboring town of Riley. Mr. Sprengle, father of L. J. Sprengle, of the Washington Republican, not only heard the meteor, but looking toward the zenith, shading his eyes from the glare of the sun, saw just below that luminary a swiftly moving mass of waving mist, followed by a double trail of bluish smoke.

This aerolite was seen by many observers at a much greater distance from the place where it fell. Mr. D. C. Ruth, of Halstead, Harvey County, Kansas (130 miles distant in a direction slightly west of south), saw a large fire ball moving through the atmosphere at a few minutes before 1 o'clock on June 25. It was also seen at Topeka (87 miles southeast) by a neighbor of H. R. Hilton, Esq. It was reported by the newspapers as having been both heard and seen at Atchison (102 miles distant), and at Leavenworth (115 miles distant), the last two places being in a direction east-southeast from Washington. A note received from C. W. Marston, Esq., of Cedar Junction (130 miles southeast from Washington) makes the following statements: "An aerolite passed in sight of this place on Wednesday, June 25, at about 1 p. m. Of the several who saw it, Mrs. John D. Randall says of it: 'It was a ball of fire as large as a table. It had a trail like a comet, and it wabbled like a kite.'"

At Beatrice, Nebraska, 40 miles northeast of Washington, it was reported as a brilliant meteor passing over the city from north to south, leaving a distinct fiery trail behind. The fact that at places to the north of the point of collision with the earth, the meteor appeared to be moving toward the south, while at places to the south it appeared to be moving toward the north, corroborates the testimony given by the nearly perpendicular sides of the hole it made in the ground, that it passed through the atmosphere from the vicinity of the zenith.

The meteor reached the ground, and buried itself out of sight 4 feet deep below the 18 inches of upper alluvium in the underlying shaly clay or "gumbo." This spot is located 3.5 miles north of Washington, in Farmington Township, about a hundred yards from the north and south road, near the southwest corner of NW. ¼ SW. ¼ Sec. 13, T. 2, R. 3 E. The farm belongs to Mrs. Lydia V. Kelsey, of Iowa, and was rented by Mr. J. H. January, who was on that day breaking the prairie sod. The noon hour had not quite expired, and Mr. January was underneath his wagon making some repairs, when he heard the sound of the approaching meteor, and came out to ascertain the cause of the disturbance. He had hardly gained the erect position, when the meteor struck the ground only a few rods distant, throwing up the earth to a height of 40 feet into the air, and outward for about 25 feet. It was also seen to strike the earth by Miss Guild, a teacher, who was returning to her home in the country after her forenoon's attendance at the Washington County Normal Institute, and was at the instant driving her horse and cart along the north and south road, only a 100 yards distant. As soon as her frightened and trembling horse had recovered from the shock, Miss Guild drove to the spot, which she reached at the same moment with Mr. January. As soon as Mr. January had calmed

his frightened horses, he began to dig for the aerolite; and with the help of a neighbor, Mr. J. D. Foster, and three other men, he reached the upper surface of the stone in one hour, but it required three hours to remove the mass from its bed, it was so firmly held in place by the compressed "gumbo." The stone was not hot when reached, which may be explained by the fact that it seems to have passed through the minimum amount of air from a direction but a few degrees south of the zenith. It was covered, however, by the usual burned crust. The stone was found to have been cracked, doubtless by the force of collision acting upon a body already under the disrupting strain of unequal temperatures. The entire mass weighed 188 pounds, and was divided by this crack into two portions, weighing respectively 144 and 44 pounds. The smaller mass was soon subjected to a process of sledge hammering by the hundreds of people who almost immediately visited the spot. Nearly every citizen of Washington has in his pocket a small fragment of the stone. The portion remaining, weighing 144 pounds, is somewhat wedge shaped, in dimensions 19 by 17 inches, by 8 inches at the base. The writer obtained from Mr. J. D. Foster for analysis a fragment weighing 2.25 pounds. In color the stone is dark slate, resembling a compact trap rock. An analysis has been made by Mr. E. E. Slosson, assistant in our chemical department.

The stone is of a gray color and resembles porphyry. A few metallic grains are all that can be detected with the naked eye. Under a microscope by chemical treatment the following minerals can be detected:

1. A white crystalline silicate, insoluble, forming about half the mass of whole; probably enstatite or a similar bisilicate of the pyroxene group.
2. A black translucent crystalline silicate, intermingled with the above, though less in amount. It is decomposed by aqua regia and contains iron; probably a unisilicate of the olivine type. These two minerals are in some fragments arranged in alternate microscopic layers of equal thickness.
3. Malleable nickeliferous iron in small irregular masses, intimately mixed with troilite and the silicates.
4. Troilite or pyrrhotite in microscopic particles disseminated through the whole rock, estimated from sulphur to be about 10 per cent.
5. Chromite, distinguishable as small black magnetic crystals in the residue after treatment with acids.
6. A few scattered siliceous crystals, yellow and red; too small to determine, probably olivine.

The following is an approximate analysis of a small fragment:

Metallic iron (with part of the iron in silicates)	14.953
Troilite	10
Soluble silicates (olivine)	25.147
Insoluble silicates (enstatite)	49.9
Nickel and chromite, undetermined.	
	100.000

Specific gravity of fragment weighing 2.5 pounds, 3.48, water at 25° C.

The characters of the meteorite were later fully described by Kunz and Weinschenk [2] as follows:

Wednesday, June 25, 1890, at 12.55 p. m., central time, in the neighborhood of 75 miles about Washington, Washington County, Kansas, a roaring, bursting sound was heard and some observers saw a meteor which moved in a northerly direction and left behind traces of smoke. The sun was shining clear and in consequence no light was observed. The explosion which followed was likened by many witnesses to the sound of a steam boiler, a clap of thunder, or a distant cannon shot. The largest piece of the meteorite, weighing about 82 kg., fell on the farm of W. H. January, near the owner, he being employed in mending a wagon, and he was considerably startled by the phenomenon. The neighbors broke off pieces weighing about 20 kg. The rest has been distributed among various scientific collections. A second piece, weighing about 4 kg., which evidently produced the second smoke, was found on the farm of J. Windhurst.

The analysis was made by L. G. Eakins, and gave the following composition of the whole stone:

Nickel-iron	7.7
Iron sulphide	5.0
Silicate soluble in HCl	46.0
Silicate insoluble in HCl	41.5
	101.2

The analysis of the nickel-iron gave:

Iron	86.76
Nickel	12.18
Cobalt	0.83
	99.77

This composition shows that the nickel-iron of stony meteorites is in general richer than the iron masses. A content of about 13 per cent nickel plus cobalt has been shown in a great number of the stony meteorites, but in iron meteorites only exceptionally. The siliceous portion of the stone remaining after treatment with the magnet was separated by hot hydrochloric acid into soluble and insoluble portions. Under I is given the result of the analysis

of the first; under II the same after the removal of the iron sulphide and reduction to 100 per cent. Under III is given the composition of the insoluble portion, and under IV the same reduced to 100 per cent.

	Soluble in HCl,		Insoluble in HCl.	
	I	II	III	IV
SiO_2	19.15	38.50	24.29	53.80
Al_2O_3	.....	.....	1.95	4.32
FeO	16.16	23.54	5.41	11.98
NiO	.34	.69	.....	.....
CoO	trace	.....	.....	.....
MnO	.17	.34	trace	.....
CrO	.....	.....	.64	1.41
CaO	.06	.12	1.84	4.08
MgO	18.31	36.81	10.10	22.37
K_2O	.....	.....	.12	.27
Na_2O	.....	.....	.80	1.77
S	1.97	.....	.....	.....
	56.15	100.00	45.15	100.00

The result of the analysis is the usual one since the portion soluble in HCl has pretty nearly the composition of olivine, while the insoluble shows a mixture of different minerals. The molecular relations of the soluble portion if Ni, Co, and Mn are included with Fe and Ca with Mg figure as follows:

SiO_2	38.50 :	59.92	=0.643
FeO	24.57 :	71.84	= .328
MgO	36.93 :	39.90	= .925

or RO_2 : RO=0.643 : 0.328+0.925

= 1 : 1.95

and FeO : MgO= 1 : 2.820 nearly corresponding to an olivine of the formula of $(Fe\ Mg_3)_2\ SiO_4$.

In the insoluble portions chromite is shown by the analysis, also a mineral of the pyroxene group, and perhaps also an asymmetric feldspar. Calculation in a stone of this kind of the constitution is, on account of its very variable composition, of no value and it must therefore be determined by the microscopic analysis given below. Macroscopically the meteorite of Washington has in fracture the characters of a doleritic lava of a dark-gray color, hard and of splintery fracture. Single white radiating chondri, as well as pieces of the same, appear in the black groundmass and in druses iron sulphide crystallizes out. The surface of these crystals is so rounded that they appear melted and measurement is impossible. The material at hand is not sufficient for analysis, although one would be of great value since the light yellow brilliant crystals show no trace of oxidation. The complete solubility in hydrochloric acid, the bright color, and the lack of magnetism indicate troilite. The same mineral is also sprinkled in the whole mass of the meteorite in fine grains. This stone easily takes a polish on account of its great hardness, and the content of nickel-iron, which only slightly appears on fractured surfaces, appears on polished surfaces in numerous grains which vary from minute to 4 mm. in diameter. Armored surfaces are beautifully shown in the meteorite, appearing on the polished faces as pretty broad, numerously branched veins which are accompanied by some iron sulphide and crust. On these faces fracture easily occurs. The crust of the meteorite is very hard, black, uneven to swollen, and occasionally 0.8 mm. thick. Its surface is dull.

Under the microscope the structure is seen to be porphyritic. The radiating chondri, also fragments and crystals of different minerals, lie in an irergular granular groundmass which is often so fine grained that it resembles a microfelsite. The whole appears to be colored by an opaque, dark brown, glassy substance which gives a dark color to the whole. In some chondri these inclusions are lacking and they have a white color. A thin section treated with cold concentrated HCl becomes colorless and the opaque inclusions become dissolved coloring the acid yellow. Hence there is no carbonaceous substance here and through heating no indication of such appears. Probably it is an amorphous ferrous silicate easily soluble in HCl. The groundmass does not have the character of a tuff but that of a rapidly crystallized substance. It shows no detritus of crystals but incomplete crystals and crystal skeletons. Most of the individuals have the form of fragments and show mechanical deformation such as is common in telluric lavas. The most prominent are fragments and crystals of olivine, partly in skeleton forms and seldom with distinct boundaries. The formation of these minerals is different from the ordinary so that it is difficult to determine them with certainty. Also prominent is a great quantity of inclusions of the dark substance so richly present in the groundmass, often arranged parallel to certain crystallographic directions. The outlines of these often appear irregular and without crystallographic boundaries resembling glass inclusions. The cleavage, uncommonly complete for olivine, can be observed, in consequence of the rapidity of the crystallization, so that undulatory extinction is a common phenomenon. This property renders the recognition of the minerals difficult. A piece of a thin section exposed to stronger heat caused one mineral to assume a red-brown color and a weak pleochroism while the other portions remained unchanged; with cold hydrochloric acid digesting in 24 hours the regularly arranged inclusions were completely dissolved and only a few black and deep brown octahedral crystals of chromite remained. This is certainly olivine of a composition somewhat different

than the analysis shows, since the inclusions dissolved in HCl would influence the result. Of other minerals a rhombic pyroxene can be observed which often shows almost fibrous cleavage and seldom has definite boundaries; also monosymmetric augite can be observed. Both these minerals are poor in inclusions and form radiating clear chondri. Feldspar may be present in the groundmass but was not found among the larger ingredients. Occasionally occurs the mineral designated by Tschermak as "monticellitelike" formed in the usual way. This contains rounded colorless inclusions with bubbles, probably of glass. The chondri appear as usual so that there is nothing to be said of them. The most various forms occur side by side. A glassy base is not present. The stone is rather completely crystalline. The iron veins appear under the microscope to be bounded by a network of a dark brown to black glassy substance which surrounds the flakes and extends pretty deeply into the adjoining mass. The meteorite of Washington belongs to the black chondrites and resembles most the meteorite of Sevrukof. It is moreover a veined black chondrite. According to its macroscopic and microscopic appearance it belongs to those meteorites which are certainly not polygenic tuffs, but cooled suddenly from a hot mass. What the conditions were that produced the features of rapid crystallization, yet gave the appearance of a completely crystalline stone, we can not now state.

In a later article which repeats many of the above statements, Kunz and Weinschenk [3] recorded the find of a distinct mass weighing 9 pounds on the farm of John Windhurst.

Brezina [5] has the following notes on the meteorite:

Farmington, which has a certain superficial resemblance to Mackinney, is distinguished from the latter by its porous character which extends to the formation of large druses (mostly lined with troilite crystals and crystal fragments) and by a richness in iron in some portions in place of the abundant troilite of the Mackinney mass. The fusion crust is very scarce on the Farmington mass, only remaining in isolated warts the size of millet seeds. In one place along the natural crustless exterior may be seen a broad black crust infiltration reaching to a depth of 3.5 cm., in which run numerous finely branched cracks for the most part filled with nickel-iron. One of these cracks is laid bare for a distance of 15 mm. and does not have the appearance of an armor face, but that of a crystalline tin-white metal plate. Another piece shows a crevice 1 mm. wide which traverses the entire piece and is lined with troilite crystals. A roundish hollow space 1 cm. in size is lined with rounded nickel-iron crystals. A small piece shows on a fractured surface a black crystal 1 cm. long of a pyroxene mineral with two cleavage planes almost perpendicular to each other, also a grain of a white monticellitelike substance. A troilite outcrop in another piece bears an imprint of half spherical form with even, glistening faces on the bottom.

In contrast to Mackinney the chondri are not very abundant. They are either leek-green or olivine color. In part they show a greenish-white coating 0.5 mm. in thickness, sharply separated from the interior, but running out into the surrounding groundmass on the exterior. Monticellite-like chondri occur.

Meunier [6] remarked the metal veins as follows:

One specimen on the Paris museum is remarkable for the almost capillary veinlets of metal alloy having an intimate analogy with the accidents of many metallic veins and contrasting absolutely with the structure which results in the case of terrestrial rocks of volcanic formation.

Preston [4] described metallic veins occurring in the meteorite as follows:

Several sections of the 136.25-pound mass of this meteorite, resembling dark gray conglomerate, show numerous small patches or grains of iron scattered through it, the largest of which is 11 by 6 mm. In the corner of three of these slices there are several veins or fissures extending from 10 to 75 mm. from the edge toward the center, some of which are filled with iron for 65 mm. in length from the edge of the slice inward and measuring 1 mm. in width. On the opposite end of the slice there is a very narrow vein about 90 mm. long which for the greater part of the way is filled with iron. Beyond the larger nodule mentioned the iron is scattered rather evenly throughout the mass in comparatively small grains.

The following suggestion as to the origin of the veins was made by Preston:

That as the meteor struck our atmosphere the concussion was so great that the mass was fractured in various places, of coarse extending from the surface inward, and the larger of these fissures or fractures were then filled by the metallic iron which was fused on the exterior surface of the mass due to its velocity through the atmosphere, and was thus forced in a molten state into its present position, thus forming the metallic veins.

This explanation was questioned by Farrington.[7] His conclusion was that the veins were phases of structure of the metallic constituents of the mass, his objections to Preston's view being the following:

First. The interior of a meteoric mass of any considerable size is so cold that portions of molten metal would be chilled before penetrating to any appreciable distance. Second. The metallic constituents of the Farmington meteorite are its least fusible ones.

The meteorite is distributed, the Field Museum possessing the largest amount (23.5 kg.).

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Fayette County. See Bluff.

FELIX.

Perry County, Alabama.
Latitude 32° 30′ N., longitude 87° 9′ W.
Stone. Spherical chondrite (Cc), of Brezina.
Fell 11.30 a. m., May 15, 1900; described 1901.
Weight, 3 kgs. (7 lbs.).

This meteorite was described by Merrill [1] as follows:

The meteorite here described fell about 11.30 a. m., on May 15, 1900, near Felix, Perry County, Alabama. For the details concerning the fall * * * the Museum is indebted to Mr. J. W. Colman, who obtained them from eye-witnesses as follows:

Mr. Robert D. Sturdevant, a farmer of Augustin, Perry County, said that while at work in his cotton field his attention was attracted by a loud rumbling noise sounding very much like thunder. It being a clear, cloudless day, he immediately looked up and saw the meteorite directly overhead. There was one very loud report, followed by two lesser ones, the appearance being compared to that of "a big piece of red-hot iron being struck with a hammer, causing many sparks to fly in all directions. After the explosion the smaller pieces popping off sounded much like a small stone or nail being thrown with great force, making a humming or hissing noise. The meteor seemed to be passing from east to west."

The main mass of the stone, weighing about 7 pounds, was subsequently brought by a colored boy to Mr. Sturdevant, who visited the locality, about half a mile away, and found that in falling it had made a hole about 6 inches deep in the soft plowed ground.

Mr. Robert S. Browning, who was on Mr. Sturdevant's place at the time of the fall, stated that "there was a rumbling noise, followed by three loud reports much like thunder or a big gun." He compared the appearance of the meteorite to that of "a big shovel of red-hot coals being upset."

Mr. W. A. Kenan, of Benton, Alabama, some 25 miles from the place where the stone was found, stated that the report was heard in Selma, Montgomery, and Marion, the latter place being about 16 miles west of Augustin.

So far as can be learned, the stone broke into three pieces, the larger of which alone is now known, the second having been lost, and the third, if such there was, never having been found.

The piece which was reserved has been broken into five, which weigh together 2,049 grams. It measured, entire, about 13 by 9 cm. in breadth and thickness. The color of the broken surface is dark smoky gray, almost black. It is very fine-grained, with numerous small dark chondri not more than 1 to 2 mm. in diameter at most, and with no metallic iron visible to the naked eye. The mass is quite soft and friable, and resembles in a general way the stones of Warrenton and Lance. * * *

Under the microscope the stone is seen to belong to the chondritic type. The essential minerals are olivine, augite, and enstatite, with troilite and native iron; the silicates occurring in the form of chondri or associated with more or less fragmental particles, embedded in a dark opaque, or faintly translucent base, which is irresolvable so far as the microscope is concerned.

The details of the microscopic structure are as follows: In a very dense, dark gray, seemingly amorphous base are scattered various silicate minerals in the form of fragments and chondri, and interspersed with occasional minute blebs of native iron and troilite. The chondri are composed of olivine, enstatite, or augite, and are sometimes monosomatic and sometimes polysomatic, holocrystalline, or with a varying amount of glassy base. Interspersed with these are fragments of olivines and enstatites of all sizes, from half a millimeter down to the finest dust. Scattered through the groundmass are proportionally large plates or clusters of enstatites. These are very light gray in color, with poorly defined outlines and extremely irregular borders projecting into black irresolvable material which forms the base. The enstatite chondri are in some cases almost completely amorphous or cryptocrystalline.

Many of the augites show polysynthetic twinning, such as was noted by Tschermak in the meteorites of Renazzo and Mezo Madras, as do also those of the meteorite of Warrenton, Warren County, Missouri. The banding is in some

cases so regular and the colors so light that it was at first thought such might be in part plagioclase feldspars. The forms are, however, those of augite; they lack the pellucidity of feldspars, and, moreover, sections of the mineral showing no twinning bands give extinctions as high as 39°. There is, therefore, apparently no doubt of their augite nature.

The most striking features of the stone are its extremely irregular, almost amorphous areas. These seem in a general way to resemble the amorphous chondri described by Tschermak from the meteorite of Grosnaja. They present, however, certain features which suggest quite a different origin. * * *

The chemical composition of the stone is shown in the analyses given below, as made in the laboratory of the department by Dr. Peter Fireman. By treatment with solution of the double salt of mercuric ammonium chloride, after the method of Carl Friedheim, there was obtained:

Metallic portion	3.04
Nonmetallic portion, including troilite and chromite	96.96
	100

The metallic portion yielded:

Fe	Ni	Co	Cu	
85.04	11.93	2.79	0.24	=100

The silicate portion was digested with hydrochloric acid and sodium carbonate solution after the usual method. The soluble and insoluble portions then yielded results as below, deducting those constituents present in combination as troilite, chromite, or as free carbon.

	Soluble silicate.	Insoluble silicate.
SiO_2	32.91	53.79
Al_2O_3	2.73	6.97
FeO	34.74	3.50
MnO	.94	.....
NiO and CoO	1.39	.....
CaO	6.43	4.33
MgO	19.39	31.33
K_2O	.11	.34
Na_2O	.70	.63
H_2O at 110°	.22	.....
	99.56	100.69

From these analyses the total chemical composition was calculated as follows:

Fe	2.59	Metallic portion =3.04 per cent.
Ni	.36	
Co	.08	
Cu	.01	
SiO_2	33.57	Stony portion =96.96 per cent.
Al_2O_3	3.24	
Cr_2O_3	.80	
FeO	26.22	
FeS	4.76	
MnO	.68	
NiO and CoO	1.01	
CaO	5.45	
MgO	19.74	
K_2O	.14	
Na_2O	.62	
C (Graphite)	.36	
H_2O at 110°	.16	
	99.79	

Mineralogical composition:

Metal	3.04
Troilite	4.76
Chromite	1.17
Graphite	.36
Soluble silicate (chrysolite in part)	72.60
Insoluble silicate (enstatite and augite in part)	18.07
	100.00

Specific gravity, 3.78 (Tassin.)

There are certain points of these analyses which I am unable, at present, to satisfactorily explain. The insoluble portion may be considered as essentially enstatite and aluminous monoclinic pyroxene and the soluble portion as largely olivine. But the high per cent of iron protoxide (FeO), as well as the lime and alumina in this latter portion, are not easily accounted for. It is possible that the last two elements may be constituents of the colorless undetermined mineral referred to, but the source of the iron protoxide is for the present unexplainable.

The case is, however, not without precedent, J. Lawrence Smith reporting similar conditions in the Warrenton, Warren County, Missouri, stone which, however, he allows to pass without comment.

For purposes of comparison, I give below the analyses of the soluble and insoluble silicate portions of the Felix and Warrenton meteorites:

	Felix		Warrenton, Missouri.	
	Soluble.	Insoluble.	Soluble.	Insoluble.
SiO_2	32.91	53.59	33.02	56.90
Al_2O_3	2.73	6.97	.12	.20
FeO	34.74	3.50	37.57	10.20
MnO	.95	.....	.....	.....
NiO, CoO	1.39	.....	1.54, .31	....
CaO	6.43	4.33	Tr.	7.62
MgO	19.39	31.33	28.41	22.41
K_2O	.11	.34	.....	.....
Na_2O	.70	.63	.07	1.00
	99.34	100.69	101.04	98.33

The dark color of the rock is undoubtedly due to the carbon it contains, since the amount of iron and troilite, as shown by the analyses, is extremely small. More than that, the finely pulverized rock, after prolonged digestion, shows a residue of carbon in the form of graphite.

The stone evidently belongs to Brezina's class of Kügelchenchondrites and to Meunier's group of Ornansites.

The meteorite is chiefly preserved in the United States National Museum.

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FERGUSON.

Haywood County, North Carolina.
Latitude 35° 36′ N., longitude 83° 0′ W.
Stone.
Fell July 18, 1889; described 1890.
Weight, 8 ounces (lost).

All that is known of this meteorite is contained in the following account by Kunz[1]:

Mr. W. A. Harrison, of Ferguson, Haywood County, North Carolina, says that about 6 o'clock on the evening of July 18, 1889, he noticed a remarkable noise west of him, and that 15 minutes later he saw something strike the earth which, on examination, proved to be a meteoric stone, so hot that he could scarcely hold it in his hand 5 minutes after it fell. Two-thirds of its bulk was buried in the earth when found. This stone was sent to the writer and was unfortunately lost in December in New York City. The stone was slightly oblong, covered with a deep black crust which had been broken at one end, showing a great chondritic structure with occasional specks of iron. Its weight was about 8 ounces and it very closely resembled the meteoric stone from Mocs, Transylvania. It remained in the writer's possession so short a time that it was not properly investigated, but still the mere mention of a fall which had been so carefully observed is thought to be well worthy of publication.

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FISHER.

Polk County, Minnesota.
Latitude 47° 48′ N., longitude 96° 48′ W.
Stone. Intermediate chondrite, veined (Cia) of Brezina.
Fell 4 p. m., April 9, 1894; described 1894.
Weight: Two masses, weight of the larger not known; weight of the smaller, 4 kgs. (9.5 lbs.).

The first mention of this meteorite was by Winchell[1] as follows:

On April 9, 1894, about 4 o'clock in the afternoon a peculiar rumbling sound startled the people of Fisher in Polk County, in the Red River Valley, northwestern Minnesota. In July of the same year while making hay on a meadow

in sec. 23, R. 49, T. 150, a stone was found which had embedded itself in the sod a few inches from the force of its fall, the impact of the mass having also turned back the turf in all directions around it. There being no drift bowlders in the region on the surface, this was at once connected with the rumbling noise. On examination it proved to be a chondritic meteoric stone. Its weight was about 9.5 pounds and it was entirely covered with the usual black crust. This being the first meteorite known to have fallen in the State, it is proposed to name it Minnesota No. 1, with a view to continue the series by suitable numeration for all future Minnesota meteorites.

In his 1895 catalogue Brezina [2] classified Fisher as an intermediate chondrite. About a year after his first mention Winchell [3] gave a full account of the meteorite as follows:

The stone is covered with a thick brown crust showing the wavy fluidal surface, indicating fusion by the application of heat to the exterior. It is pitted with the usual depressions and prominences. Of the two pieces that fell, one was immediately broken up by the farmers, who desired, as they said, to know whether any gold was inside of it. The fragments were scattered amongst them and some were taken into North Dakota. The other stone remains entire. The one which was broken up was the larger of the two, the smaller one weighs about 9.5 pounds. Several of the pieces of the larger mass have been recovered and from these this description was written, except as to the exterior appearance, which is described as it occurs on the smaller mass. The coating, however, on the smaller fragments has no noticeable difference from that on that of the unbroken mass.

The specific gravity of the stone is 3.44.

The color is light gray, but flecked with rustiness from oxidation of the iron. The iron is not abundant, but is found in isolated grains varying in size from a mere speck to 1.5 or 2 mm. in diameter. The broken surface glitters with scattered bronzy reflections, apparently of troilite.

In thin section the stone, aside from the iron elements, appears to be principally a granular mass of olivine more or less rusted, and of enstatite, showing occasionally the chondritic structure. The olivine seems to have been entirely shattered from its crystalline integrity and to exist now in the form of more or less angular cleavage and other fragments impacted together and held in place by a secondary cohesion. Still, in general, the individual fragments are not far removed from their original positions, and in some instances are sufficiently large to operate on with convergent light with crossed nicols.

The polarization colors are high. Of the numerous sections afforded by the slices some are found perpendicular to the different axes of elasticity. In one perpendicular to ng(c) two cleavage systems are distinctly apparent which intersect each other at right angles, although these are crossed by other coarse cracks which cut the grain into many irregular fragments. These cleavages are those parallel to the brachypinacoid (010) and the base (001), the latter being less evident than the former. Extinction takes places parallel to these cleavages.

Another section is cut perpendicular to nm(b) and has a bright bluish-green color. It extinguishes parallel to its principal cleavage (010), the other cleavage being reduced by the shattering which all the grains have suffered to an irregular series of cross fractures of the lamellæ 010, hardly continuous enough to be recognized as cleavage. This section is parallel to the base. Other basal sections show no basal cleavage.

Another section with two distinct rectangular cleavages is perpendicular to np(a), which in olivine indicates a section parallel to the brachypinacoid. One cleavage is straight and clear, the other coarse and somewhat irregular. Extinction is parallel to these cleavages.

There are numerous sections which have extinction at a varying angle with the cleavage owing to their obliquity with the principal zones.

The chondri are composed of olivine and enstatite. The various lamellæ consist of many individual granules having a common orientation and the lamellæ themselves extinguish in unison and frequently parallel to their elongation. Occasionally a granule not exactly in line with the series constituting one of the lamellæ, but rather between two lamellæ, extinguishes at a different angle. The lamellæ in the olivine chondri are nearly straight and parallel. Between them is sometimes an isotropic substance which is probably glass, but sometimes this substance affords an aggregate polarization. In those olivine chondri in which the lamellæ are cut parallel to 001—that is, perpendicular to the mean axis of elasticity—the distinct cleavages run directly transverse to the elongation of the lamellæ as viewed. Hence the lamellæ are of the nature of plates parallel to 100. Sometimes the lamellæ contain no interlamellar glass, but the alternate lamellæ are differently oriented, there being two directions, with an angle of about 24° between them. Sometimes parts of different chondri are closely adjacent, each having its independent orientation. In this condition the appearance somewhat resembles the radiating lamellæ of the chondri of enstatite and in some of the enstatite chondri olivine constitutes a portion of the interlamellar mineral.

There are apparently two isotropic substances in this meteorite, one being glass (at least glassy) and the other having a cleavage. The latter is clear as glass in ordinary light and has refraction approaching that of olivine, as shown by the shagreen which is produced on lowering the condenser. It may be maskelynite, which is a mineral discovered by Tschermak in 1872, isotropic but having nearly the composition of labradorite. A sketch shows the aspect of the cleavable grain in common light with the condenser lowered. This indeed is the only grain of the isotropic substance showing a distinct cleavage. The noncleavable substance appearing like glass is rather widely distributed, but there is no certainty that they are the same, although the glassy substance seems occasionally to transmit a little light between crossed nicols. The cleavable mineral has occasionally a trace of a second cleavage.

There is this distinction between these isotropic substances, viz, the glassy grains, as appears in the chondri of olivine where the interlaminations between the lamellæ of olivine are in part of this glassy substance, on becoming

crystalline gradually transmit light and have four extinctions. But the cleavable mineral, when perfectly crystalline, is continually dark between crossed nicols. They, therefore, belong to different crystalline systems.

In consideration of the specific gravities of the principal elements of this meteorite there appears to be reason to look for the presence of a lighter mineral than olivine. Thus:

Olivine	Iron	The stone	Maskelynite
3. 30	7. 50	3. 44	2. 65

The small amount of iron present would probably raise the specific gravity of the stone higher than 3.44 if not counteracted by a lighter mineral.

The metallic iron is bright and silvery when polished. The larger pieces are about 1.5 mm. in diameter but the smallest are mere specks. They are dispersed among the other grains in a very irregular and fortuitous manner. Some of the finest fragments are in the chondri.

Troilite is in about the same proportion as metallic iron. It has a dark bronzy luster. * * *

About a year later a further study of the meteorite was reported by Winchell and Berkey [5] as follows:

For the purpose of further determination of the mineral which resembles maskelynite, two micro-chemical tests were made. The particles are so small that no chemical examination is practicable, viz:

1. Particles belonging to group 2, i. e., glass.
2. Particles of a translucent mineral which showed angular fracture and but little or no cleavage, presumed to be the doubly refracting mineral which is like maskelynite, and possibly represented by groups 5 and 6.

With the first the test revealed lime and soda. With the second were developed, along with fluosilicates of lime, a liberal sprinkling of hexagonal rods of fluosilicate of soda.

There is not enough of this mineral present to warrant an attempt at quantitative analysis. It remains, therefore, undecided whether the meteorite contains maskelynite. The evidences in favor of its presence are:

1. A feebly polarizing mineral, low in double refraction, occurring in the midst of the chondri and elsewhere.
2. This mineral shows little or no cleavage.
3. It contains lime and soda.
4. The glass from which it seems to have crystallized also contains soda and no soda has been detected in the other minerals.

An analysis of some small fragments of this meteorite was made by C. P. Berkey, of the University of Minnesota. Preliminary qualitative tests showed the following elements: Silicon, aluminum, iron, nickel, calcium, magnesium, and sulphur. Silicon occurs as the oxide, forming the mineral tridymite and also occurs in the silicates maskelynite, olivine, and enstatite. Aluminum, calcium, and magnesium and a part of the iron occur in the silicates. Nickel is present native, or possibly forming an alloy with the iron. Iron is present in three forms, metallic iron, ferrous oxides in the silicates, and ferric oxide chiefly as an oxidation from the native metal.

Sulphur is present in small quantity in the mineral troilite. No alkali metals were found.

The bulk of the analysis gave:

Silica, SiO_2	41. 16
Alumina, Al_2O_3	6. 60
Iron, calculated as Fe	24. 26
Magnesia, MgO	19. 03
Lime, CaO	4. 34
Nickel, calculated as Ni	2. 26
Sulphur, S	Traces.
	97. 65

In the above analysis all the compounds appear in the correct chemical combination with the exception of iron and sulphur. Sulphur should appear as FeS, but the small amount obtained made such estimate impracticable. A part of the 24.26 per cent of iron should be estimated as FeO and also a part as Fe_2O_3, which will then bring the analysis to the proper total amount.

The lacking 2.35 per cent should properly be accounted for in this way; 6.89 per cent of iron disposed of in this way satisfies the chemical proportions.

The meteorite is distributed among collections.

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FLOWS.

Cabarrus County, North Carolina.
Here also Cabarrus County, Cabarras County, and Monroe.
Latitude 35° 13′ N., longitude 80° 32′ W.
Stone. Gray, veined chondrite (Cga), of Brezina; Erxlebenite (type 34), of Meunier.
Fell 3 p. m., Oct. 31, 1849; described 1850.
Weight, 8.8 kgs. (19.5 lbs.).

The first account of this meteorite was given by Silliman[1] from the account by Gibbon,[1] as follows:

On the authority of a communication from J. H. Gibbon, of the branch mint of the United States at Charlotte, North Carolina, we give a condensed view of facts regarding a fall of meteoric masses in that State, not having room for the less important details.

On Wednesday, October 31, 1849, at 3 p. m., several persons in the town of Charlotte were astonished, and not a few were exceedingly terrified, by a sudden explosion, followed at short intervals by two other reports, and by a rumbling in the air to the east and south.

The sounds were distinct, and continued more than half a minute; they were imputed by some to thunder, but there were no clouds, the evening was calm and mild like the Indian summer, and only a mist was seen in the eastern horizon; nor were the impressions of others better founded that the explosions were due to the blasting of rocks on a railroad; but Sheriff Alexander, having once before witnessed the explosion of a meteor, justly traced the detonation to that cause.

The negroes, who are very acute observers of sounds in the open air, denied the thunder, and an old fisherman said that the reports were like those of three pieces of heavy artillery followed by the base drum. Horses both in harness and under the saddle started with alarm.

Inquiry began to be made for fallen stones, and on Monday a servant of the mint brought in a report from Cabarrus County, 25 miles distant, that there were notices stuck up on the trees inviting people to come and see "a wonderful rock that had fallen from the skies on the plantation of Mr. Hiram Post."

Mr. Gibbon, of the mint, with Dr. Andrews, traveled 21 miles, and partly at night by torchlight, to see "the large mass of metallic rock." They found, placed in a conspicuous position upon a barrel elevated upon a post,[a] "a bluish gritty rock," of irregular form, 8 inches long, 6 broad, and 4 thick, bearing marks in spots of recent fracture, but otherwise black as if it had been exposed to heat and smoke, the black color being relieved where the crust had been broken, and a little of the clayey soil in which it was buried in its descent still adhered to it. It had the curved indentations usual in meteorites, as if it had been soft and yielded to impressions, and lustrous metallic points appeared through the ground color, which had generally a bluish slaty appearance, but no such rock was known in the neighborhood. Mr. Post took the travelers by torchlight to see the place where the mass fell. He was at the time in company with a young man on horseback; they heard overhead a whizzing sound—the whole atmosphere appeared to be in commotion—they compared the sound to that of a chain shot, or of platoon firing. Nothing was visible; but their attention being directed by the sound toward a large pine tree east of them, they heard the stone strike "with a dull, heavy jar of the ground," while the dog, in terror, crouched at his master's feet.

Mr. Post (in his peculiar language), had sighted the sound, and his negro man plowing in a field had done the same from a different direction, and by ranging with the aid of these intersecting lines, they found the stone the next morning, which had splintered a pine log lying on the ground. By sounding with a sharp stick in the hole made by the stone in its fall they soon found it, and extricated it from its hiding place, which was 10 inches below the surface; the dried leaves which had been "driven about by the percussion," aided in discovering the spot, which was in the woods about 300 yards from the place where Mr. Post had stood at the moment of the fall, but there were no marks on the trees, although the impression was that numerous small bodies had fallen, "making a noise like hot rocks thrown into water."

Mr. Gibbon and his companion viewed the place both by torch and daylight, and were convinced of the accuracy of the statement.

The people of the vicinity imagined that a rock had been thrown up from a volcano or from blasting, or had come from the moon, and were not easily persuaded that it could be formed in the atmosphere.

As is usual in cases of extraordinary celestial phenomena, some were terrified by the supposed approach of the day of judgment, or of war, or some other dire calamity, and a militia colonel, in a spirit quite professional, said that "there must be war in Heaven, for they were throwing rocks."

At the request of Doctor Andrews, the stone was diverted from another destination, in favor of Prof. Charles U. Shepard, of the Medical College of South Carolina, at Charleston, from whom we learn that at a recent date the specimen had not yet reached him.

[a] With laudable liberality and caution joined, the worthy proprietor of the boon which had fallen on his land had annexed a written notice: "Gentlemen, sirs—please not to break this rock, which fell from the skies and weighs 19.5 pounds."

In due time we shall have the result of his scientific examination, but from the circumstances we have no hesitation in admitting this case as genuine. The facts are perfectly familiar to hundreds on record, and in many particulars are in accordance with the remarkable event of this nature which happened in Weston, Connecticut, in December, 1807, and with which the senior editor of this journal, with his college colleague, Professor Kingsley, was at the time familiar. There is no room to discuss theories, but we feel fully assured that aerolites are not formed in our atmosphere, are not projected from terrestrial or lunar volcanoes, but have a foreign origin, giving us the only reports of the physical constitution of other worlds which have ever reached our earth.

By an additional communication from J. H. Gibbon, dated November 29, 1849, it is rendered probable that "luminous materials were seen advancing from several points in the atmosphere toward a common center, where a solid mass of heated metal (materials) exploded and was violently projected in different directions to the earth."

It is stated also that there was a distinct appearance of a single fiery elongated body, like iron advanced to a white heat, sparkling in its passage from west to east, rising like a rocket but not vertically, and passing through the air with a long white streak or tail following a denser body in the form of a ball of fire. ("The true flaming sword of antiquity.")

Still it is to be observed that neither the fireball nor any light was seen by many who heard the successive reports and the fall of the stones, and the rumbling "like loaded wagons jolting down a rocky hill." (This was the very comparison used at Weston, in December, 1807, by the people there, in describing a portion of the reports heard on that occasion.) But this is no way extraordinary, as it was daytime, with a clear sky, and those only would see the fireball who were looking in the proper direction at the time "when it was in its most ardent state." At the explosion, the meteor was about 45° high.

The estimation of time between the disappearance of the light and the arrival of the sound was very different, as made by different persons, at several minutes, even as high as five. The latter supposition would make the meteor almost extra atmospheric, but doubtless the period of five minutes is much too high, and we infer that the meteor, like that at Weston, was fully within the atmosphere, and probably not over 15 or 20 miles from the earth when it exploded. It was seen through 250 miles from the line of Virginia to Sumter district in South Carolina, and from east to west it was seen through 60 miles.

A further account and analysis was given by Shepard [2] as follows:

This stone fell at 3.15 p. m. on October 31, 1849. The place of fall was upon the estate of Mr. H. Bost, which is situated in the northwest corner of the county, 18 or 20 miles from Concord, its shiretown, 22 miles east from Charlotte, and 15 miles from Monroe, the county seat of Union. An account of the principal circumstances attending the fall of the mass has been given by Dr. J. H. Gibbon, of the United States Branch Mint, at Charlotte, which appeared in a late number of the American Journal of Science. Additional particulars of the same phenomenon have been afforded by the same gentleman which were published in the National Intelligencer. As abstracts from both these sources have been made by several papers in different sections of the country, it will be unnecessary to take up time here with further particulars on this part of the subject. A few additional facts communicated to me by Dr. William D. Kersh, of this State, and by Dr. E. H. Andrews, of Charlotte, may be communicated on a future occasion.

For an opportunity of describing this stone I am indebted to the kind offices of Doctors Gibbon and Andrews, of Charlotte, both of whom repaired immediately to the place of fall and secured for me the refusal of the mass. It was soon afterwards purchased by Doctor Andrews and transmitted to me here, thus affording me the pleasure of exhibiting it to the association almost precisely in the condition in which it was found.

The present weight is 18.5 pounds, it having been reduced 1 pound by the abstraction of two or three fragments by those who saw it prior to the visit of Doctors Gibbon and Andrews.

The shape reminds one the most forcibly of a human foot inclosed in an india-rubber overshoe. It nevertheless exhibits several tolerably distinct planes giving rise to a low, irregular, four-sided pyramid truncated at the summit and having for a base a somewhat rounded undulating surface. Its greatest length is 10.5 inches, its height 5.5 inches, and its breadth 6.75 inches. The sides present the indentations and the angles the blunt terminations which are so common in these bodies.

The crust is thin, black, and strongly coherent, having a smooth surface with exception of minute projections occasioned by metallic grains. In point of luster it is quite dull. Minute portions of yellowish clay and fibers of lignin (the former from the soil into which it fell and the latter from the tree against which it struck) are still visible upon portions of the surface.

An attempt to break the mass for obtaining a fresh view of the interior revealed a remarkable difference between this and most meteoric stones. It required repeated strong blows with a heavy hammer to detach a fragment of 1 pound weight; and the fracture was at last effected only where a fissure had before been observed, and where a sort of natural joint with perfectly glazed plumbaginous surfaces had existed. In force of cohesion it fully equals most trappean rocks.

Its ground color is of a dark bluish-gray stained with fine rust points. It is mottled with rounded grains and crystals of a lighter-colored mineral, rendering the mass when closely viewed subporphyritic. Though rich in nickeliferous iron and pyrites, these ingredients can scarcely be discovered upon a fractured surface owing to the fineness with which they are interspersed.

It is the first example belonging to the trappean order of stones which has been described in the United States, and approximates most closely to the rare stone of Tabor, in Bohemia, which fell July 3, 1753.

It is strongly magnetic. Its specific gravity varies from 3.60 to 3.66.

The composition of the stone as a whole was found to be—

Nickeliferous iron (with traces of chromium)	6.320
Magnetic pyrites	3.807
Silica	56.168
Protoxide of iron	18.108
Magnesia	10.406
Alumina	1.797
	96.606
Traces of lime, soda, and potassa, with loss	3.394
	100.000

The earthy portion of the meteor is made up of two (possibly three) distinct minerals. One of these is olivinoid to the amount of one-third or one-half of the entire mass. It is in rounded or subangular grains, like one variety of leucite in certain lavas. Its color is grayish-white, with a tinge of lavender blue. The size of the concretions vary from that of a mustard seed to that of a peppercorn. The other mineral is dark bluish-gray. It is fine granular, approaching compact, and constitutes the paste or cement which holds the alumina and metallic ingredients together. It is impossible to separate it for investigation by itself and to determine whether it is a described mineral or new. It seems more probable that it is the latter, and that it belongs to the feldspar genus. It certainly differs from howardite and from anorthite by very marked properties.

Wadsworth [4] gave the following observations:

The specimen in the Harvard College cabinet shows the usual chondritic structure and contains considerable iron. The grayish-white minerals with a tinge of lavender blue are the chondri which are well marked in this meteorite. It possesses a striking similarity to the Iowa County meteorite, although the chondri are somewhat smaller. Judging from the general character of the Cabarrus meteorite, it is probable that Shepard's analysis is incorrect, and it is to be hoped that a new one will be made.

Tschermak [6] figure an olivine chondrus of the meteorite surrounded by an iron rim.

The name Flows was first applied to this meteorite by Farrington [7] who states that the name of Monroe, Cabarrus County, often applied to the meteorite, is incorrect, since Monroe is 18 miles distant from the place of fall and not in Cabarrus County. The name Flows is suggested since the fall took place near the post office of that name. The origin of the name Monroe as applied to the meteorite is not known to the present writer.

The meteorite is distributed, but the largest quantity of the mass, 14 pounds 10¾ ounces, is in the Amherst collection. In addition Wülfing lists 4,798 grams.

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Floyd County. See Indian Valley.

Floyd Mountain. See Indian Valley.

Fomatlan. See Tomatlan.

FOREST CITY.

Winnebago County, Iowa.
Here also Kossuth County, Leland, and Winnebago County.
Latitude 43° 15′ N., longitude 93° 45′ W.
Stone. Brecciated spherical chondrite (Ccb) of Brezina; Chantonnite (type 42) of Meunier.
Fell 5.15 p. m., May 2, 1890; described 1890.
Weight: Shower of stones, 5 large ones of 80, 66, 10, 4, and 4 pounds, respectively, and 500 to 1,000 weighing from 0.05 to 20 ounces each.

The first scientific mention of this shower of meteorites was by Torrey and Barbour [1] in 1890 and was as follows:

This large and brilliant meteor fell in northern Iowa on the afternoon of May 2, 1890, at 5.30 o'clock and was widely observed throughout the adjoining country. It appears that the phenomenon was rather in the nature of a meteoric shower judging by appearances and the fact that several complete meteorites of considerable size (10, 70, and 100 pounds) were found at long distances from each other with a number of smaller ones. The splendor of this great luminous ball, bright even in full sunlight; its fiery cometlike tail, 3° to 4° in length; and the long train of smoke lingering behind it fully 10 minutes and plainly marking its course in the sky inspired all who saw it with awe. It is described as sputtering through its course like fireworks. To the students who saw it enter the atmosphere it appeared to start a few degrees below the zenith and to pass below the horizon to the north-northwest of this place, descending at an angle of 50°. The meteoric shower covered an area 2 or 3 miles wide near Forest City, Winnebago County, Iowa, while one meteorite, weighing 100 pounds, passed into Kossuth County. These meteorites belong to the stone class. Their most notable feature is the large amount of metal contained in the fragments examined, it amounting to 45 per cent by weight. The metal is in exceedingly small globules and thin flakes, making its separation from the matrix a matter of considerable difficulty. The specific gravity of the matrix was 2.63; of the metal free from matrix 5.75.

Analysis gave:

SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	
47.03	29.43	2.94	17.58	2.96	=99.94

At the same time a study of the orbit of the meteorite was given by Newton [2] as follows:

The newspaper accounts of the Iowa meteorite of May 2, 1890, are definite enough to give a fair idea of its orbit around the sun before entering our atmosphere. The path that best satisfies the accounts that seem to be reliable was directed from a point a little north of west and somewhat higher than the sun, the sun being about 20° high and due west. The velocity of the meteorite may be safely assumed to have been greater than that of Encke's comet at distance unity, and less than that belonging to a parabolic orbit. With this assumption the orbit would be inclined to the ecliptic between 10° and 20° with direct motion. The ascending node is in longitude 42.5°. The body had passed perihelion several weeks, how long depends mainly upon the inclination to the horizon of the path through the air. The perihelion distance was probably between 0.50 and 0.70, this element also being largely dependent upon the same inclination.

In October of the same year a further account was given by Kunz [3] as follows:

On Friday, May 2, 1890, at 5.15 p. m. standard western time, a meteor was observed over a good part of the State of Iowa. It is described as a bright ball of fire moving from west to east, leaving a trail of smoke which was visible for from 10 to 15 minutes; it was accompanied by a noise likened to that of heavy cannonading or thunder, and many people rushed to their doors thinking it was the rumbling of an earthquake. Authentic reports of it came from Des Moines, Mason City, Fort Dodge, Emmetsburg, Algona, Ruthven, Humboldt, Britt, Garnet, Grinnel, Sioux City, and Forest City; the noise was also heard at Chamberlain, South Dakota. Some of these places were distant more than a hundred miles from the point where the meteorite fell. It exploded about 11 miles northwest of Forest City, at Leland, Winnebago County, in the center of the northern part of Iowa, latitude 43° 15′ N., longitude 93° 45′ W. of Greenwich, near the Minnesota State line, and the fragments were scattered over an area 1 mile wide and nearly 2 miles long. Masses weighing, respectively, 80, 66, and 10 pounds have been found, two of 4 pounds, and about 500 fragments weighing from 0.05 to 20 ounces each, while a part of the mass is believed to have passed over into Minnesota. The pieces are all angular with rounded edges.

The meteorite is a typical chondrite apparently of the type of the Parnallite group of Meunier. The stone is porous, and when it is placed in water to ascertain its specific gravity, there is considerable ebullition of air. The specific gravity on a 15-gram piece was found to be 3.638. The crust is rather thin, opaque black, not shining, and under the microscope is very scoriaceous, resembling the Knyahinya (Hungary) and the West Liberty (Iowa) meteorites.

A broken surface shows the interior color to be gray, spotted with brown, black, and white, containing small specks of meteoric iron from 1 to 2 mm. across. Troilite is also present in small rounded masses of about the same size. On one broken surface was a very thin scum of black substance, evidently graphite, soft enough to mark white paper; a feldspar (anorthite) was likewise observed, as well as enstatite.

Results and analyses furnished by L. G. Eakins.

Approximate composition of the mass:

Nickeliferous iron	19.40
Troilite	6.19
Silicates soluble in HCl	36.04
Silicates insoluble in HCl	38.37

Analysis of the nickeliferous iron:

Fe	Ni	Co	P	
92.65	6.11	.65	trace	=99.41

Specific gravity of the mass, 3,804 at 28.5° Celsius.

Soluble in HCl.				Insoluble in HCl.		
	1	2	3[a]		4	5[a]
SiO_2	17.82	17.82	39.74	SiO_2	26.49	55.51
FeO	14.27	8.26[b]	18.42	Al_2O_3	2.59	5.43
NiO	.17	.17	.38	Cr_2O_3	.12	.25
MnO	Trace.	Trace.	.....	FeO	4.49	9.45
CaO	.31	.31	.69	NiO	Trace.	.....
MgO	18.28	18.28	40.77	CaO	1.45	3.00
Alkalies	Trace.	Trace.	.....	MgO	11.50	24.09
S	2.67	(c)	.....	K_2O	.07	.15
P_2O_5	Trace.	Trace.	.....	Na_2O	1.01	2.12
	53.52	44.84	100.00		47.72	100.00
O for S	1.34					
	52.18					

[a] Calculated to 100 per cent.

[b] Minus 6.01 FeO, equivalent to 4.67 Fe, required by S to form FeS (troilite).

[c] Minus 2.67 S to form FeS (troilite).

The approximate composition of the mass was got by extracting everything possible by an electromagnet, which took out all the nickel iron and a little troilite, leaving the siliceous part and most of the troilite. Then the amount of S present in the magnetic portion and that in the siliceous portion was calculated as FeS, the silicates were split into two portions by HCl, and by the weights found in each case the given approximate composition was calculated. Under the head of analysis of nickeliferous iron is given the analysis of the metallic portion after allowing for a very slight amount of attached silicates and troilite.

The analyses numbered from 1 to 5 are the residue left after removing all the magnetic material. Column 1 is the part soluble in HCl, column 4 that insoluble in HCl; these two added together would give the analysis as a whole of the nonmagnetic portion. Column 2 is the same analysis as 1, after removing the 2.67 per cent S and an amount (6.01 per cent) of FeO equivalent to the Fe necessary to form troilite with the S. Column 3 is the same as 2 calculated to 100 per cent. Column 4, as stated, is the analysis of the insoluble portion and 5 is the same to 100 per cent. It is of course probable that the Cr_2O_3 represents chromite, and possible that the alkalies and alumina with a little lime represent a soda-lime feldspar.

In 1891, Torrey and Barbour [4] published a further account of the fall, as follows:

The Winnebago County meteorite fell near the new town of Thompson, 11 miles northwest of Forest City, Winnebago County, at 5.15 p. m., May 2, 1890. Seven large fragments are noted, weighing, respectively, 86 pounds, 66 pounds, 10 pounds, 10 pounds, 60 ounces, and 60 ounces, and, according to Prof. N. H. Winchell ,about 5,000 small fragments weighing from the fraction of an ounce to a pound or more. Between two and three hundred small fragments are in the collection of Yale University alone. About 100 pieces and the 66-pound piece are in the University of Minnesota. Others are owned by Ward and Howell, Rochester, New York, and by Geo. F. Kunz, New York City.

The dead-black, scoriaceous crust, when broken, reveals a light gray stone interspersed with innumerable dark particles of iron, and globules of troilite, quite like the Iowa County stones in appearance. Thin seams and cracks occur occasionally filled with a substance that has somewhat the appearance of graphite, and small spheroidal masses of olivine are abundant. The specific gravity is 3.638.

Chemical composition of the matrix from a fragment of the 66-pound aerolite:

SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	
47.03	29.43	2.94	17.58	2.96	=99.94

This is but the approximate composition, and it is our opinion that nothing else should be offered, and that no analysis yet published is strictly reliable, owing to the nonhomogeneous character of the matrix. Another difficulty not sufficiently recognized is the practical impossibility of separating the iron from the matrix by the magnet, owing to the infinitesimal division of the iron, which is still visible under the microscope, even in the impalpable powder.

A partial analysis of the metallic portion gave:

Fe	Ni	Si	C	Mn	S	P	
95.79	2.89	0.03	undt.	undt.	0.68	0.54	=99.93

The so-called 104-pound fragment or "Kossuth County aerolite" deserves notice here from the fact that it figured in all the earlier notices, at least, as the largest fragment of the Winnebago County meteorite, being sold to parties in Forest City as such, whereas it is simply a fraud. Pieces of the bowlder commonly called "nigger head" were sent us at once for examination. Analysis showed it to be a diorite or allied rock, without crust; no metal present. Gravity (2.83) about one unit lower than that of the meteorite.

In its passage the meteor was seen throughout all Iowa, and observers report it from Kansas, Dakota, and Minnesota.

However exaggerated the press reports may have been in certain instances, the fact of its splendor stands nevertheless; so, too, the fact of the terror which the sudden light, the hissing passage, and terrific explosion inspired in the people of northern Iowa, especially Winnebago County and immediate vicinity. Reports from all the towns and cities for many miles around Winnebago County liken the noise of the explosion to heavy cannonading, accompanied by a "rushing sound" or unearthly hissing and a noticeable tremor which caused the citizens to fly from their houses to inquire into the cause. This vivid display occurred in the face of a bright spring sun, and an almost cloudless sky. The dazzling head, likened to the moon in size, "sputtering" and throwing off a long train of sparks; the heavy line of black smoke left in its wake to mark its course for a full 10 or 15 minutes; all were seen and marvelled at by the people of several States.

Its course to the eye was from southwest to northeast, and its inclination to the earth most commonly judged to be about 55°. One well-authenticated but surprising report comes from Tabor, in the extreme southwestern corner of the State, to the effect that the "noise there was like thunder, and was compared by some to an earthquake shock, the jarring of the ground being so evident; and that four distinct explosions were observed by one." This is a point of considerable interest, for at Grinnell but faint noise, if any at all, accompanied the transit. Although the clamor over a hotly contested game of ball on the athletic field of the campus hindered the students and faculty, who saw it, from making careful observations on this point, yet to satisfy ourselves we visited all the farmers for some 20 miles northwest of Grinnell to find but one who thought possibly he heard a noise in connection with the passage through the air. It was surely accompanied by little or only imaginary noise at this point.

The train of smoke left by the meteorite seems worthy of notice.

The velocity of the meteorite was such that its transit through the earth's atmosphere was momentary, and at the time the head passed below the horizon the entire course of the meteor was marked by a broad ribbon of smoke, having straight, sharply defined edges. This ribbon of smoke tapered off toward the higher atmosphere, as if vanishing in perspective, showing the great rarity at that elevation. The smoke began to curl away gradually, but lingered for a full 15 or 20 minutes before disappearing entirely. The fall was largely on unimproved land near Thompson, covering with fragments an elliptical area some 2 or 3 miles long by 1.5 wide. (It seems as if the major axis might be taken roughly as the direction of the meteor, that is, northeast, as it appeared to the eye; or, as Professor Winchell suggests, the line of direction is more nearly that of the line of impact of the large fragments, that is, northwest.)

The 66-pound fragment buried itself, close to a farmer in the field, more than three feet in the hard prairie soil. It was not dug out till the next day. Prof. N. H. Winchell, who visited the spot at once, states it was not hot when dug out, notwithstanding all reports to the contrary, and that the clay around it was neither baked nor in any way changed; and that the 86-pound stone fell on old turf, where last year's grass remained dry, and after the stone was taken out, portions of the grass carried down by it, adhered to the surface unburned. Besides, one piece fell on a straw stack and did not fire the straw.

The paper of Torrey and Barbour is accompanied by township maps, showing the area covered by the meteorites, also by drawings of the 66-pound stone and the microscopic appearance of sections. The map shows that the fall took place in Linden and King Townships, northwest of Forest City and Leland.

Newton [6] observed lines of structure in polished surfaces which he described as follows:

The polished surface of a small specimen of this stone, 3 or 4 sq. cm. in area, shows several hundreds of bright metallic points. The larger iron particles in this area have great varieties of shapes, the smaller ones are usually mere points. When seen with a lens, or even at a distance from the eye suited to distinct vision, there does not appear to be any regular structure or arrangement of the bright points. But if the surface is so held as to be a little beyond the point of distinct vision and at the same time turned around in such a way as to reflect always a strong light to the eye, either skylight or lamplight, there appear lines of points across the polished surface of the stone, which suggest very strongly the Widmannstätten figures on metallic meteorites. At times as the stone is turned no lines can be detected. Again, one set of parallel lines or two sets crossing each other become visible. Some of the sets are very sharply manifested, and some are so faint as to leave one in doubt whether the lines are real or only fancied. There are on the surface in question six or eight of these sets of lines.

A second surface was ground nearly parallel to the first, at about 1 cm. distant from it, and like lines appeared on this parallel surface. Some of the lines, but not all of them, corresponded in direction in the two surfaces. Four more surfaces approximately at right angles to the first surface, and corresponding to the faces of a right prism were then ground and upon these surfaces the like sets of lines appear with greater or less distinctness.

These markings are such as we might expect if the forces which determine the crystallization of the nickel-iron of the iron meteorites also dominated the structure of the rocklike formations of the stony meteorites and the distribution therein of the iron particles. The relation of quartz crystals to the structure of graphitic granite is naturally suggested by these meteoric markings.

Brezina,[7] in 1895, made the following observations:

Forest is distinguished by the great number of complete individuals weighing from 40 kg. down, on which, as in the case of Mocs and Pultusk, numerous formations, especially those due to fusion, are to be seen. Armor formation

and cosmic division according to the armor faces are present, as well as secondary incrustation of all degrees, crust spattering, drift, lines of pittings, less frequently crackling of the front side, ridges of crust on the border line between the front and back side, brown to reddish-brown thin crust or less frequently thick bark crust on the rear side. Now and then a stone has reversed orientation. Neither globular nor brecciated formations are very distinctly marked, and few individuals show either one or the other prominently.

The accounts show that neither of the names which have been given this meteorite, Forest City or Leland, accurately show the location of fall. Apparently, however, Forest City was as near the point of fall as Leland, and as this name has gained vogue it may as well stand.

The meteorite is distributed, many collections possessing numbers of the small individuals. The 81-pound stone is in the American Museum of Natural History collection; the 66-pound stone at Minneapolis. The Field Museum possesses about 700 individuals; New Haven also has a large number.

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FORSYTH.

Monroe County, Georgia.
Latitude 33° 0′ N., longitude 83° 55′ W.
Stone. Veined white chondrite (Cwa), of Brezina; Luceite (type 37, subtype 2), of Meunier.
Fell 3.30 p. m., May 8, 1829; described 1830.
Weight, 16 kgs. (36 lbs.).

The first account of this meteorite was published among Miscellanies in the American Journal of Science, as follows:

Having recently received from Dr. Boykin specimens of the meteoric stone which fell in Forsyth, in Georgia, in May, 1829, we are induced to republish an extract from an original statement of the facts, as it appeared in the newspapers at the time.

"Between 3 and 4 o'clock, on May 8, a small black cloud appeared south from Forsyth, from which two distinct explosions were heard, following in immediate succession, succeeded by a tremendous rumbling or whizzing noise passing through the air, which lasted, from the best account, from two to four minutes. This extraordinary noise was on the same evening accounted for by Mr. Sparks and Captain Postian, who happened to be near some negroes working in a field 1 mile south of this place, who discovered a large stone descending through the air, weighing, as was afterwards ascertained, 36 pounds. The stone was, in the course of the evening, or very early the next morning, recovered from the spot where it fell. It had penetrated the earth 2.5 feet. The outside wore the appearance as if it had been in a furnace; it was covered about the thickness of a common knife blade with a black substance somewhat like lava that had been melted. On breaking the stone, it had a strong sulphurous smell, and exhibited a metallic substance resembling silver. The stone, however, when broken had a white appearance on the inside with veins. By the application of steel, it would produce fire. The facts as related can be supported by many individuals who heard the explosion and rumbling noise, and saw the stone. Elias Beall."

The following notice, forwarded to the editor by Dr. Boykin, of Georgia, under date of June 2, 1830, corresponds substantially with the above:

"No one can tell from what direction the meteor came. The first thing noticed was the report, like that of a large piece of ordnance; some say the principal explosion was succeeded by a number of lesser ones in quick succession; similar to the explosions of a cracker; one has told me the secondary noise was only a reverberation. Very soon after the explosion some black people heard a whizzing noise, and on looking saw a faint 'smoke' descend to the ground; at which time they heard the noise produced by the fall of the stone. They ran to the spot, for they saw where it fell, and discovered the hole it had made in the ground, being more than 2 feet in a hard clay soil. The negroes and others who went early to the spot, say they perceived a sulphurous smell. The stone weighed 36 pounds; it fell at a small angle with the horizon."

Having received the specimens, just as this number of the journal is about being finished, I can add only the following notice: The color of the interior of the stone is a light ash gray, and very uniform, except that it is sprinkled

throughout with thousands of brilliant points of metallic iron, having very nearly the color and luster of polished silver. The iron is rarely in points larger than a small pin's head, but the points are so numerous that nearly the whole of the powder of the stone is taken up by the magnet, even when it is in fine dust, and by a magnifier the little points of iron can even then be seen standing out from the magnet. It greatly resembles the Tennessee meteorite.

It has the usual black crust on certain parts, and this, although resembling a semifused substance, exhibits bright metallic points when a file is drawn across it. A similar black crust is seen pervading the stone in some places through its interior, and forming, where it is seen in a cross fracture, black lines or veins. The stone is full of semifused black points and ridges similar to the crust, and its entire mass seems half vitrified in points, so as to resemble an imperfect glass. The specific gravity, as ascertained by Mr. Shepard, is 3.37.

Shepard [2] gave an analysis of the meteorite as follows:

Having been supplied, through the kindness of President Church and Professor Jackson, of the University of Athens, with a specimen of this scarce stone weighing half a pound, I have been able to subject it to analysis, as well as to determine its specific gravity more accurately than I had been able to do before. It is 3.52. It contains the following ingredients:

Nickel-iron (Fe, 89; Ni, 9.6; Cr and loss, 1.4)	10
Howardite	70
Olivinoid and anorthite	10–15
Magnetic pyrites	2–5
Apatite	Trace

Analysis gave:

SiO_2	FeO	MgO	CaO	Al_2O_3	
50.00	33.33	9.30	5.30	1.80	=99.73

Brezina, in 1885 [3] placed this meteorite among the unveined white chondrites; but in 1895 [4] he placed it among the veined white chondrites, remarking that both of the Tübingen specimens, one of 2 and the other of 59 grams, were veined white chondrites.

Wülfing [5] is able to account for only 741 grams, which is distributed. In addition Amherst has 6½ ounces (about 170 grams). Wülfing's query, as to whether the main mass is at Athens, Georgia, in the University of Georgia, was answered in the negative in a letter received by the writer from the Chancellor of that institution.

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FORSYTH COUNTY.

Forsyth County, North Carolina.
Latitude 36° 5′ N., longitude 80° 15′ W.
Iron. Nickel-poor ataxite, Nedagolla group (Dn) of Brezina.
Found, 1894; described, 1896.
Weight, 22½ kgs. (50 lbs.).

The history and characters of this meteorite have been summarized by Cohen [3] as follows:

E. A. de Schweinitz states that this iron was found on a farm in the southwestern part of Forsyth County, North Carolina, by a plowman, that it weighed about 22.5 kg., had an irregular wedge-shaped appearance, and was covered with a thin coating of rust. The iron was extraordinarily tough and yielded no Widmannstättian figures upon etching, but showed a dappled crystalline structure.

His analysis gave:

Fe	Ni	Co	S	P	
94.90	4.18	0.33	0.22	trace	=99.63

When, upon the ground of its chemical composition, de Schweinitz expressed the belief that this was a part of the Guilford County meteoric iron it appeared to be entirely without foundation. On the one hand the latter is an octahedral iron, on the other hand the analysis by Shepard used for comparison of the two may not be correct.

Stürtz, who obtained the block from G. F. Kunz in New York, requested me to examine and describe it more exactly. I was the more ready for the task inasmuch as Schweinitz had not given sufficient information concerning the

structure of the meteorite, and the analysis, which was evidently merely a provisional one, indicates an unusually low percentage of nickel and cobalt.

Already the cursory examination of the etched section had given the unexpected and startling result that the block possessed no individual structure. The difference is so marked that at first, as I possessed only sections cut from both ends, I was convinced that a mistake had been made and that pieces of two different meteorites had been sent me. Not until I reassembled all the fragments obtained by dissection (altogether 17.2 kg. with a section face of 1,537 sq. cm.) did it become evident to me that here was a meteorite which was granular on one end and amorphous on the other. Such a phenomenon appears never to have been observed before.

Variation of structure has indeed been noted before in a few instances, but so far as can be determined from the meager descriptions extant it has affected only a small area, so that the general character of the meteorite is unitary; while in the present case the whole meteorite can be divided into two portions having different structure and in general quite distinctly marked off from one another. Characteristics similar to those of Forsyth would be expected soonest in the meteoric irons of Floyd Mountain, Holland's Store, and Summit; but whether such characteristics are actually present can, naturally, only be determined definitely when each meteorite is as completely disclosed as happened in the case of Forsyth.

When, from the individual fragments into which Forsyth has been broken up, the original form has been reconstructed, a three-sided, sharp-pointed pyramid is obtained whose lower half is semiglobular in form. On the thinner end the nickel iron consists of small grains of nearly the same size. Most of them have a diameter of 0.25 to 0.5 mm.; only in very isolated cases does it exceed this by a small amount, and the number of smaller grains lying between the former is also comparatively small, so that from a not too exact observation of the structure it seems conspicuously of a uniformly granular character. While the grains are, moreover, almost isometric they are not round, but with many small excrescences. The larger number glisten at a certain position of the section. If the latter be examined under a magnifying power of 50 diameters by reflected light it is evident that each grain possesses the same structure as the rest of the iron, only very much finer. Each grain is composed of grains from 0.02 to 0.03 mm. in size, a portion of which are more vigorously attacked by the etching than the rest, so that by sufficient magnifying power fine pittings of apparently uniform size and distribution appear upon the surface. These pittings apparently produce the above-mentioned sheen. They are scarcely bounded by crystal facets; then when the reflection is placed under the microscope it returns first upon turning the section through 360°.

This portion of Forsyth then may be designated, like Locust Grove, as "granular ataxite," a group which hitherto has not been more sharply defined. The lower thick portion of the block is essentially different in character from that of the upper sharp end. A section through the former upon etching takes on to the unaided eye an entirely homogeneous appearance, such as could be produced only by a very uniform fine structure. The etched surface appears perfectly dense and dull, with a velvet-like luster, and seems exactly similar to the etching surface of a Babbs Mill specimen. Under a very strong glass a very fine structure, as in the case of Babbs Mill, may be discerned; the individual grains may measure 0.02 mm.

The boundary between the denser and the more granular nickel iron runs somewhat like a cut aslant through the pointed portion of the block, so that two pieces running to a sharp pointed wedge shape are formed, of which the densely compacted part forms about six-sevenths and the granular part one-seventh of the meteorite. Of the pieces obtained by division, therefore, one large end piece weighing 7.5 kg., the next largest sections (together weighing 3,600 gr.), and a 11-cm. slice cut from the side and weighing 1.5 kg., are entirely or almost entirely amorphous. Thereupon follow sections with small granular particles on the border until finally the latter predominate, and lastly the two end pieces obtained from the pointed part of the pyramid are entirely granular. While the two sorts of nickel iron are sharply marked off from one another in the larger portion, still the direction of the boundary face is very irregular in the smaller. The granular and the amorphous portions penetrate one another in manifold bendings, and upon the section surface numerous isolated granular particles lie in the amorphous portion, and vice versa. Often these are projecting portions cut off by the section, but this is not always the case, since not infrequently toward the border the granular parts may be seen to break up and resolve into small groups or even isolated grains until finally the amorphous iron alone prevails. At the same time, however, the border remains ever distinct, inasmuch as there is no gradual diminution in the size of the grains, but each isolated grain shows essentially the same size as individual grains in the aggregate, and the differences in structure likewise remain entirely distinct. A figure gives a clear view of the character of the border, the section being taken from the same portion of the meteorite in which both sorts of nickel iron are about equally well developed.

The granular and the amorphous nickel iron show remarkably different effects from treatment with hydrochloric acid; the former is readily etched with dilute acid, the latter is only slowly attacked by concentrated acid.

The number of accessory constituents, in respect to the abundance of the materials at disposal for investigation, is small, section surfaces occurring of from 60 to 70 and even occasionally of 110 sq. cm. in size from which they are entirely wanting. Troilite occurs most abundantly of all. The larger nodules are of an ellipsoidal form and attain a length of 17 mm. and a breadth of 10 mm. When they are found near the border they are as a rule surrounded by a broad, considerably rusted zone, and a portion of the latter may have been formed at the expense of the iron sulphide. Occasionally in the large ones the boundary is very regularly ellipsoidal, in the small ones delicately bent. Many particles of troilite are elongated and irregularly bounded; for example, there is one 15 mm. long and only from 1 to 2 mm. broad. Finally there are also small roundish grains with a diameter of 1 mm. and from that diminishing down to mere points in size; to these belong small dark round specks.

Especially in the middle portion of the block rounded nodules of graphite are found, in addition to the troilite, which attain a length of 8 mm. and a breadth of 6 mm., but which as a rule are of only small size. Occasionally, too, graphite occurs as a scaly envelope of larger troilite nodules, while an intimate admixture of both minerals, such as is not infrequently seen in other meteoric irons, is not present in this.

The nickel-iron phosphides can be discerned with certainty only by the aid of a strong glass. Rhabdite appears to be entirely wanting, and only here and there are small tin-white granules of schreibersite visible. In a few places are to be seen extremely thin laminæ, as much as 5 mm. in length, which appear under a strong glass merely as hair lines. They would be easily overlooked were they not for the most part surrounded with a small aureole of rust. This arises apparently from the fact that iron chloride appears on the borders of the leaflets, while the surrounding compact nickel iron, which is free from accessory constituents, remains entirely fresh. According to the analogy of Locust Grove these lamellæ may be regarded as nickel-iron phosphides; although they are much finer in Forsyth, shorter and scarcer, and therefore not, as there, characteristic of the meteoric iron.

Likewise, only in isolation and upon a few places in the meteorite are to be found peculiar spindlelike formations, which attain a length of 2.5 mm. and a thickness in the middle of 0.25 mm. Something similar may be observed in the Cape iron, where the formations are larger and sometimes sharp at the one end only, while the other is cut straight off. They resemble hemimorphic prismatic forms terminated at one end by a base, at the other by a pyramid. In the case of the Cape iron, the color of the forms in reflected light suggests iron sulphide; here they are so small that only a conjecture concerning their nature can be expressed. Many of the lamellæ and spindles are surrounded with a fine light etching zone.

All these inclusions show a preference for the amorphous portion of the meteorite. In the granular part, graphite is entirely wanting; schreibersite, which must be present from the content of phosphorus shown in the analysis, does not occur macroscopically, and troilite occurs only in isolation. Most of the nodules of graphite and troilite, as in the case of Locust Grove, lie in proximity to the original crust of the meteorite.

Forsyth belongs to those meteorites which, in consequence of their content of chlorine, rust easily and abundantly. The first is evidenced by the fact that a freshly etched section (especially of the granular variety) quickly acquires specks of rust from lying in the air, the last is inferred from the abundant coating of rust on specimens submitted by Stürtz and from a comparison of the given weights. According to de Schweinitz, the block weighed originally about 22.5 kg., while Stürtz estimated the weight after the exfoliation of rust-crust at 20.300 kg. As de Schweinitz mentions only a thin coating of rust, it must have formed more than 2 kg. of rust within a comparatively short period of time.

For the purpose of ascertaining the chemical composition of the iron, pieces of the granular and the dense portions, as widely separated as possible, were taken and submitted to exactly the same method of analysis; both pieces were free from visible accessory constituents. The test of the granular portion for manganese and chromium gave a negative result, and hence, in the case of the amorphous portion, was neglected.

Analyses (Sjöström):

	Fe	Ni	Co	Cu	C	S	P	Cl	
Granular.....	94.18	5.56	0.60	0.02	0.04	0.05	0.19	0.17	=100.81
Amorphous....	94.03	5.55	0.53	0.02	0.02	0.03	0.23	trace	=100.41

The chemical composition of both varieties, with exception of the content of chlorine, is as good as identical; that the chlorine is less in the dense portion than in the granular, leads to the supposition that the latter rusts very much easier than the former.

From the above data are obtained the following mineralogical composition:

	Granular.	Amorphous.
Nickel-iron (kamacite)	98.33	98.42
Phosphides	1.23	1.49
Troilite	0.14	0.08
Lawrencite	0.30	0.01
	100.00	100.00

The specific gravity of a section of the granular variety was determined by Leick as 7.3357, and that of the amorphous variety as 7.4954. Since these values are unusually low, the first determination was repeated, but with the same result. The abnormal specific gravity may be referred to the porosity of the mass, and in fact the granular section after two and a half hours developed bubbles, when it was submerged in water under the air pump to remove the adhering atmospheric air. In this connection it must be remembered that some time previous a lower specific gravity than had been hitherto found in meteoric iron, was obtained for Lick Creek on which a few porous places were observed with the unaided eye, although this was heavier than that of the present case.

If the accessory constituents be disregarded, the specific gravity of the nickel-iron of the granular variety is 7.3872, that of the dense variety is 7.5066; in reality, the values should be somewhat higher, since the rust coating adhering to the small quantity of the section could not be brought into the computation.

Since the chemical composition of the two varieties is essentially the same, the difference in specific gravity, as well as the varying resistance to the etching acid, can be occasioned only by the divergence in structure.

Three determinations of the chlorine in the rust coating were made as follows:

After boiling with water	3.55 per cent.
After treatment with cold, dilute nitric acid	3.48 per cent.
After heating with dilute sulphuric acid	4.99 per cent.

The large amount of chlorine in the rust coating (4.99 per cent), in comparison with the small amount in unaltered nickel-iron (0.17 per cent), is explainable as a result of diffusion, and the strength of the same is governed by the greater or less porosity of the nickel-iron. That the latter, in the case of Forsyth, is particularly strong would be inferred on account of the conspicuously low specific gravity.

As to the origin of the two varieties of structure: Since the chemical composition of both varieties is the same, the manner of the cooling of the iron can alone be assumed as the cause of the structural differences; accordingly, the granular structure must have been the central, slower cooled portion of the meteorite, the dense or amorphous portion the peripheral mass. If this is actually the case, the very irregular border running along with the present exterior surface would indicate that the meteorite originally had a very different form, and that a flaking off had taken place, which separated the densely constituted portion on the one end of the block. This would also explain why the accessory masses of troilite and graphite lie preferably in the dense portion, since they usually predominate in the peripheral portion of iron meteorites. Moreover, the form as indicated by the figure submitted by de Schweinitz does not militate against the assumption that a splitting off of portions of the mass took place.

The specific magnetism of a granular portion was determined by Leick as 0.21; of a compact portion as 0.57, and of a partly granular, partly compact piece as 0.17 absolute units per gram. The permanent magnetism of all three pieces was very weak.

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FORT DUNCAN.

Maverick County, Texas.
Latitude 28° 35′ N., longitude 100° 24′ W.
Normal hexahedrite (H), of Brezina.
Under the name of Fort Duncan Brezina and Cohen group the following:

1. Sanchez (Sancha) estate, Coahuila, Mexico. (Also called Saltillo, Couch, Cauch, or Gouch.) Iron, found 1850, weight 114.33 kgs. (231.5 lbs.).
2. Smithsonian iron ("locality unknown" in many catalogues). Described 1881, weight 3,638 gr. (8 lbs.).
3. Fort Duncan, Maverick County, Texas. Found 1882; described 1886; weight 43.5 kgs. (96 lbs.).

Here also, according to Brezina, a small specimen of the Vienna collection which Jackson sent under the designation: "Taos, New Mexico, Sierra Blanca, N. Santa Fé, 144 km. south of the Gila River."

The history and characters of these meteorites are summarized by Cohen [19] as follows:

Sanchez Estate.—According to the data from Lieutenant Couch the mass at Saltillo was used as an anvil, but originated from Hacienda Sanchez (Sanchez Estate), 50 to 60 miles from Santa Rosa in the north of Coahuila, where several other iron masses of considerable dimensions have been found. When the mass reached the Smithsonian Institution it weighed 114.25 kgs. (252 lbs.), although Smith [2] concluded from the presence of plane boundary surfaces that it was originally heavier. According to the illustration furnished by Smith its form is cylindrical with projecting points, saucerlike pittings seeming to be wanting. The exterior shows only slight traces of chlorine. The iron is malleable and not hard to cut and gives an etching surface similar to that of Braunau. After treatment with hydrochloric acid finely divided schreibersite remains behind in brightly glistening flakes. Other minor constituents were not observed.

According to Fletcher,[13] Genth's analysis [1] of a specimen, for which New Mexico was erroneously given as the locality, belongs to the same iron (Sanchez Estate). Rose [3] observed on this supposed New Mexico iron etching lines and rhabdite.

Burkart [4] left it uncertain whether Sanchez belonged to Coahuila, but considered it probable. Brezina [18] identified it with Fort Duncan and cited the abundance of rhabdite, which on the one hand is evenly distributed through the entire mass, on the other hand in especially large examples is crowded together in long parallel layers, surrounded by a common etching area.

Fletcher [13] thinks that the mass may have been brought to Saltillo by way of Santa Rosa to be used as an anvil, and that the Hacienda Sanchez lies north from Santa Rosa where the Bonanza iron was found. If Coahuila and Fort Duncan, including Sanchez Estate, are considered different irons Fletcher's view would naturally be incorrect. Huntington [9] determined the specific gravity of five different pieces and obtained values from 7.631 to 7.925, which led him to conclude that the material was not uniform. Further, according to him, Sanchez as well as Duncan, in contrast to Coahuila, show complete cubic cleavage and large cleavage planes are distinguished by lack of striations and by a scaly appearance such as is characteristic of many alloys. A small section which I received from the Gregory collection under the name of Saltillo shows abundant etching lines, regular distribution of rhabdite, and marked resistance to acid.

Analysis by O. Bürger gave the following:

Fe	Ni	Co	Cu	Cr	P	S	
94.62	4.79	0.60	0.04	trace	0.18	trace	=100.22

The Smithsonian iron was described by Shepard[5] in 1881 as an iron of an unknown locality in the old Smithsonian Museum at Washington. He observed on an etched surface a uniformly oriented sheen and concluded, therefore, that the mass was an individual. A concealed banding and the appearance of compact shining flecks gave the iron a peculiar structure. There was no formation of iron chloride. His son gave the following analysis (specific gravity, 7.589):

Fe	Ni	Co	Cu	Schreibersite	
92.92	6.07	0.54	trace	0.56	=100.09

Brezina[18] united the Smithsonian iron, on account of its resistance to acids and its richness in rhabdite, with Fort Duncan. He also mentioned upon it well-marked etching pits and very fine Neumann lines, some systems of which were continuous, others pinnately developed on long striæ parallel to one another.

Fort Duncan was first mentioned in 1886 simultaneously by Hidden[7] and Brezina.[8] According to Hidden[7] the mass weighing 43.5 kgs. was found by Cusick on an old river terrace on the Rio Grande in the neighborhood of Fort Duncan. It had the form of a flattened ellipsoid and was covered with a thin, generally dull, somewhat blistered crust. One face showed large depressions and small indentations. On moderate etching two systems of lines appeared which could be referred to twinning lamellæ. On stronger etching these disappeared, and lines consisting of minute schreibersite lamellæ, arranged according to different directions but comparable in appearance to quartz in pegmatite, appeared. For recognition of this structure magnification was necessary. To the naked eye the etched surface appeared weakly spotted. Hidden noted an abundance of troilite and schreibersite in his preliminary note, but in his later description, mentions only two short fissures filled with graphite and a small nodule of troilite. He considered Fort Duncan similar to Auburn, Hex River, and Lick Creek, but different from Coahuila and Sanchez Estate. He gave the following incomplete analysis by Mackintosh:

Fe	Ni+Co	P		
94.90	4.87	0.23	=100	Specific gravity=7.522

Brezina[8] determined Fort Duncan to be a hexahedrite, noted its unusual resistance to acids, its richness in rhabdite greater than that of any other iron, its similarity with Sanchez Estate, and a scarcity of troilite. In 1895 he[18] mentioned in Fort Duncan Reichenbach lamellæ 8 cm. in length in the neighborhood of which the Neumann lines were lacking. He also noted hemispherical pits on the surface, due to the melting out of troilite, and bent edges on the point of impact of the mass.

I have noted above, under Sanchez Estate, that Huntington[9] at first considered Fort Duncan, Sanchez Estate, and the Butcher irons, Coahuila, as belonging together, but later[11] he separated the first two from the last.

Meunier[10] noted the similarity of Fort Duncan to Braunau, likewise an abundance of troilite, some of which was surrounded by graphite containing bands of daubreelite and showing polygonal boundaries. He separated Fort Duncan from Coahuila; the former he placed in the group of Braunite, but the latter he regarded as forming a single group, Coahuilite, which is distinguished by difficult solubility in acid. Brezina made an exactly opposite observation. Meunier[10, 15] furnished two incomplete analyses as follows:

Fe	Ni	Residue		
92.02	6.10	1.80	=99.92	Specific gravity=7.699
91.90	7.03	....	=98.93	Specific gravity=7.72

In 1889 I published an analysis[12] as follows:

Fe	Ni	Co	P	Residue	
92.58	6.66	0.73	0.28	0.01	=100.26

As I was later in doubt of the correctness of this analysis I made a further new investigation, and the following new analysis by Hildebrand resulted (specific gravity, 7.8437):

Fe	Ni	Co	Cu	Cr	P	S	Residue	
94.65	4.82	1.07	0.04	0.04	0.23	0.32	0.02	=101.19

Linck[14] found the sheen oriented according to at least five different planes of 112 and concluded that the brilliancy of the orientation was dependent on the breadth and abundance of the twinning lamellæ. When he later recognized that etching pits also contributed to the oriented sheen he did not mention Fort Duncan especially but must have intended to modify his view in general.

According to the above investigations Sanchez Estate, Saltillo, and Fort Duncan masses have in common an unusual resistance to etching with nitric acid and to solution by hydrochloric acid. Most iron meteorites dissolve in very dilute hydrochloric acid (1HCl+20aq.), but a piece of Sanchez Estate weighing 35 grs. lay 8 days in such a solution unchanged, and even an acid twice as concentrated as this acted upon it very slowly. Fort Duncan will not receive a complete polish, large portions remaining rough. In these places under a lens can be distinguished closely crowded minute needlelike or short linelike depressions which run parallel to one another. These seem to originate in small rhabdites, which on account of their brittleness break out under polishing. In the same way as found by Brezina for Sanchez and the Smithsonian iron Fort Duncan shows numerous very fine and very long etching lines first plainly distinguished under the lens. Occasionally they are crowded together in great number; in other places they lie isolated. Shorter etching lines are not lacking but are much rarer than in other hexahedrites and are only recognizable by careful study of an etched surface. Besides the small rhabdites which are often first made known by the above-mentioned

depressions larger ones are present which reach the length of a millimeter and are arranged in zones 0.5 to 1 cm. distant from each other, within which they are quite regularly arranged in their longest direction. These are surrounded by a common dull zone in which only the finest etching lines can be recognized. The other needles are apparently arranged regularly, but it can not be determined whether they lie parallel to the three directions of the cube or not. On account of the great number of fine rhabdites and the depressions referable to these it is difficult to determine how much the etching pits have to do with the lively, oriented sheen. Fort Duncan seems to be poor in larger accessory constituents. Both Sanchez Estate and Fort Duncan acquire strong permanent magnetism and possess quite strong cohesive force. After strong heating and slow cooling a piece of Fort Duncan acts like soft iron, while rapid cooling after heating to a bright red is without effect. Leick's [17] determination of the specific magnetism of Fort Duncan on a triangular piece is .27 and on Sanchez Estate .69 units per gram. Among the constituents isolated by dilute hydrochloric acid from Sanchez Estate were single rhabdites 0.25 to 0.66 mm. thick and 1.33 mm. long which were suitable for crystallographic study. There were also granules of chromite and silicates. The majority of the rhabdites consist of very fine needles which are somewhat larger in cross section than those of Coahuila. They are generally from 0.05 to 0.02 mm. in width. Thin plates of schreibersite occur in small numbers also. Daubreelite could not be found in a piece weighing 35 grams.

Analysis of the rhabdite of Sanchez Estate gave:[16]

Fe	Ni	Co	P	Residue	
55.01	28.63	0.60	15.24	0.71	=100.19

The composition of Sanchez Estate calculated from the isolated constituents is as follows:

Fe	Ni	Co	Cu	P	Residue	
92.25	6.96	0.53	0.01	0.23	0.02	=100

Since no complete analysis has been made of Sanchez Estate it is not certain whether it possesses a so much higher content of nickel and cobalt than Fort Duncan or Saltillo, as the above analyses would indicate, or whether the analysis is incorrect.

The mineralogical composition of the three irons calculated from analyses is as follows:

	Nickel-iron.	Rhabdite.	Troilite.	Daubreelite.	Chromite.	
Sanchez Estate	98.49	1.49	....	....	0.02	=100
Fort Duncan	97.66	1.48	0.73	0.11	0.02	=100
Saltillo	98.83	1.17	....	....	....	=100

According to the above observations Fort Duncan is distinguished by a considerably smaller number of short etching lines, the appearance of large rhabdites distributed in layers, scarcity of accessory constituents, resistance to acids, and perhaps by lower content in nickel and cobalt.

These meteorites do not seem to have been much distributed. According to Clarke's Catalogue, 105 kgs. of Sancha Estate is in the U. S. National Museum, although Tassin's Catalogue does not list it. Brezina's Catalogue of 1895 lists 12 kgs. of Fort Duncan.

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FORT PIERRE.

Stanley County, South Dakota.
Here also Nebraska.
Latitude 44° 21′ N., longitude 100° 20′ W.
Iron. Medium octahedrite (Om), of Brezina; Caillite (type 18), of Meunier.
Found 1856?; sent to St. Louis 1857; mentioned 1858; described 1860.
Weight, 16 kgs. (35 lbs.).

The first mention of this meteorite is found in the Transactions of the Academy of Science of St. Louis.[1] Chouteau is there said to have presented to the Academy a mass of meteoric iron of 35 pounds weight found in Nebraska Territory about 20 miles from Fort Pierre. A further account was given later by Holmes [2] as follows:

This mass of iron was brought down from Fort Pierre to St. Louis by the American Fur Company's steamer in charge of Mr. C. P. Chouteau, in 1857, and by him presented to the Academy, in the spring of 1858. It was said to have been found in Nebraska Territory, at a point about 20 miles from Fort Pierre, which is situated on the right bank of the Missouri River, in latitude 44° 19′ N., longitude 100° 26′ W., nearly. The weight of it when found was 35 pounds; when presented to the Academy, it weighed 30.5 pounds, a piece having been previously cut off as a specimen. Since that time, two other specimens, weighing together about 3.5 pounds, had been cut off at the same end and presented by the Academy, the one to Prof. C. U. Shepard, of New Haven, and the other to the Imperial Mineralogical Museum of Vienna.

In form and shape it was irregular, somewhat flattened, with rounded corners and obtuse edges. On three sides the surface was covered with irregular depressions or indentations. One of these sides is a concave surface filled with these indentations, or wavy depressions. The color of the outside was brownish black; the inside (cut or fracture) had the light gray metallic color of iron; and the cut surface showed flaws in the mass. The outside color was merely superficial, and there had been but a slight degree of oxidation of the surface. Prof. C. U. Shepard, who had an opportunity of examining it, thought it could not have been upon our earth more than four or five years. The iron was soft under the cutting tool, and the workmen engaged upon it, as well as Mr. Albert Dwelle, foreman of the Fulton Foundry, whose attention had been called to it, at the time, had been well satisfied that they observed a distinct smell of something like camphor in the process of cutting.

The length was 11 inches, breadth 4.6 inches; thickness at one end 6 inches, at the other, 3 inches, tapering suddenly to an obtuse edge.

Analysis by H. A. Prout gave the following:

Fe	Ni	Mg	Ca	S	
942.88	71.85	6.50	3.50	trace	=1024.73

Prout also states that the nickel is entirely free from traces of cobalt, chromium, manganese, or other elements sometimes found in these masses.

Shepard,[3] under the title of the Nebraska iron, gave an account as follows:

This mass was found near the Missouri River, between Council Bluffs and Fort Union. It originally weighed about 35 pounds, but is reduced to 29. Its shape was an oblong, compressed oval, not unlike that of the Chesterville, South Carolina, iron mass, which has been compared by me to a thick, blunt edged fresh water clam (*Unio*).

Its surface is as black and smooth as that of the Braunau iron, from which, however, it differs in being more even and smooth, though not destitute of the usual indentations belonging to meteorites, but these are by no means uniform in their occurrence over the entire surface. The crust is everywhere extremely thin, amounting to scarcely more than a mere varnish; and, what is very remarkable, is often insufficient to hide the Widmannstätten figures.

The lines are not equally displayed throughout, and indeed generally require a single lens in order to be distinctly seen. Nor have they the same beautiful regularity as when obtained by etching upon a polished surface from the interior. They are, moreover, curiously knotted, so as to resemble under the microscope the blunted teeth of a fine saw blade. The configuration upon the etched plates of this iron resemble that of the Texas mass, though the bars are much more rectilinear, and in this respect approach nearer to the African irons from Namaqua Land and Orange River. The fullest regularity of internal structure does not prevail, however, until some depth from the outer surface or crust is reached.

This iron is entirely free from earthy, plumbaginous, or pyritic matter. The character of the surface renders it certain that this mass must be of very recent fall.

Its specific gravity is 7.735.

Haidinger [5] gave the following account of the piece which he received:

I received a piece weighing 1 pound and had it cut through the largest diameter and both faces polished. One of the remaining pieces, 2½ inches long, 2 inches wide and 10 lines thick, is bounded upon one side by this section surface, upon the other is mostly bounded by the natural surface, which is fairly even between the rounded edges, and has only very shallow pittings.

This piece also has the peculiar dark-brown crust of meteoric iron in small portions, while upon the prominent parts it has long been rubbed or cracked off.

On both sections the finer threads of white metals can be seen, showing the structure of the Widmannstätten figures.

Fortunately the section running most distinctly according to the form lies almost exactly parallel to the plane of an octahedron.

The bands intersecting one another at angles of 120° and 60°, according to Partsch, run in perfect parallelism over the entire etched surface, having a width of about one-half line with triangular and rhomboid interspaces between the inclosing films of schreibersite. They manifest quite unmistakably an enduring crystalline activity through a period for which we have as yet no measure. Neither the cleavage nor the laminated structure parallel to the cubic faces is seen as in the Hauptmansdorf iron, nor the crystal damask sheen, as in the Bohumilitz iron, comes to view here, but the true Widmannstätten figures, as seen in the Elbogen, Agram, and Durango irons, very similar also to the structure of the great mass of iron of 1,635 pounds weight from Red River (Louisiana or Texas). The zigzag lines which appear in the figure are disruptions of the crystalline mass, parallel to the octahedrons.

The specific gravity at 12° (C?) was 7.362 in the case of the larger fragments. It would probably be higher in case of the smaller fragments, since the cracks present (on the exterior) indicate possible separations in the interior.

Madelung [6] made the following analysis:

Fe	Ni	Co	P	Insoluble	
90.764	7.607	0.889	trace	0.053	=99.313

G=7.741.

Brezina [8] in 1885 stated:

The laminæ measure 0.8 mm. in width and are finely flecked.

Meunier [9] states:

Etching produces a perfectly normal etching design where the three elements of the caillite appear with their characteristics most perfectly defined.

Brezina [10] described sections in the Vienna collection as follows:

A section lengthwise almost through the entire mass of a specimen in the Vienna Museum shows a zone of alteration 0.5–3 mm. wide along the natural exterior and is entirely covered with a system of octahedral cracks, which follow the course of the laminæ, in consequence of which frequent zigzags from one lamina to another occur along the principal laminæ, giving the appearance of the ramifications of lightning flashes. Another piece shows pressure figures 2–3 cm. in size and the slightly altered fusion crust with elongated outcroppings of troilite with daubréeilite bands. On a third slice the zone of alteration, which measures in this case 1–1.5 mm. in width is not glistening as usual, but shows a different orientation of luster without other change. The laminæ are of the same dull appearance as the fields, which are mostly filled with repetitions of the laminæ.

The meteorite is distributed. The largest piece (10 pounds) is in the museum of the Academy of Science of St. Louis.

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10. 1895: Brezina. Wiener Sammlung, p. 277.

FRANCEVILLE.

El Paso County, Colorado.
Latitude 38° 48′ N., longitude 104° 35′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1890; described 1902.
Weight, 18.3 kgs. (41.33 lbs.).

This meteorite was described by Preston.[1] The following is an abstract of his account:

This iron was found by Mr. David Anderson, about 1890, on Government land in El Paso County, Colorado, 1.5 miles southwest of the home ranch of Skinner and Ashley, which is east of Franceville. In Mr. Anderson's own words, "It was totally above ground, and I found no signs of any other. When I found the meteorite, I simply pushed it with my foot, but I found I could not move it. The following day I went back with a wagon and got it to the ranch. I do not think at the time the land was entered by anyone; it was not near to any road."

The meteorite, from the time at which it was found until purchased by Professor Cragin, of Colorado College, was kept in the home of Mrs. Anderson, in Colorado Springs, half forgotten, and when Professor Cragin called to see it, was finally found beneath an old lounge.

The weight of the iron is 41 pounds 6.5 ounces, or 18.3 kg.

In form it is a decidedly flattened rhombic pyramid, with a somewhat sharp ridge extending around the center of the mass on the four rhombic sides. The dimensions of the mass in these directions are 21 by 23 cm. On one side of this central axis the pyramid projects 6 cm., on the opposite side 5.5 cm.

Two small corners of the mass have been broken off and have the appearance of very old breaks, as the surfaces are entirely oxidized. These surfaces show a markedly octahedral cleavage.

The decidedly octahedral form of this iron seems unquestionably due to its separation along natural cleavage planes from a much larger mass. But it is surprising that the form should not have been much more distorted by the erosion due to friction in passing through the atmosphere.

The whole iron is more or less mottled, ranging in color from a reddish brown to a brownish black, and is entirely covered with pittings on all sides. Those on the upper side are much more distinct, owing to their size and depth, than elsewhere.

Upon slicing the mass, but one troilite nodule of any size was found. This occurred on one end piece and the adjoining slice, and was 14 mm. in diameter, with two small patches of nickeliferous iron in its center.

The slices show more or less of fractures extending across their surfaces along the natural cleavage faces, the edges of the kamacite plates, and in some instances the rhombic forms produced by the Widmannstätten figures are strongly outlined by these fissures. The figures are readily brought out by etching and are particularly sharp and clear and of large size.

The kamacite plates average from ½ to 1.5 mm. in diameter, with an occasional one of 2 mm. They are unusual, from the fact that they extend in an unbroken line in many instances from 90 to 120 mm. in length. The tænite occurs in minute films between the kamacite plates.

The plessite patches are comparatively small for an iron of such coarse crystallization. Some of these patches show no structure when etched, except a slightly pitted surface, while others are prominently made up of alternate layers of kamacite and tænite, producing the sharply defined Laphamite lines.

Schreibersite is not visible on the etched surfaces megascopically, nor even surrounding the troilite nodules, as is usually the case.

Analysis by J. M. Davison:

Kamacite and tænite	99.160	Soluble in HCl.
Combined carbon, not determined.		
Schreibersite	0.837	Insoluble in HCl.
Graphite and silicates (trace)	0.003	
Platinum (from 23.9 grams)	trace	
	100.	

Composition of kamacite and tænite:

Fe	91.92
Ni	8.13
	100.

The meteorite is distributed.

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FRANKFORT.

Franklin County, Alabama.
Here also Francfort, Franckfort, and Franklin County.
Latitude 34° 30′ N., longitude 87° 50′ W.
Stone. Howardite (Ho) of Brezina.
Fell 3 p. m., December 5, 1868; described 1869.
Weight, 615 gr. (1.35 lbs.).

This meteorite was described by Brush,[1] his account being chiefly as follows:

Mr. Benjamin Pybas, of Tuscumbia, Alabama, who took great pains in collecting all the facts connected with the fall, states:

"The meteorite fell December 5, 1868, 4 miles south of Frankfort, the county town of Franklin County, Alabama. The country around Frankfort is broken and hilly, being the termination of the western branch of the Cumberland Mountains. Frankfort is 16 miles southeast of Tuscumbia.

"Mr. James W. Hooper witnessed the fall, and describes it as follows: 'About 3 p. m., the afternoon being cloudy and cold, we heard a strange, harsh, roaring noise up in the air. Three distinct reports were heard; at first these were supposed to be cannon, but the noise immediately changed into a series of bursting sounds, like a great fire blazing and crackling through the air. It appeared to pass from the north toward the south. Immediately after the first sound or roaring had passed over, another was heard coming from the same direction; like the whizzing of a bomb-shell as it cuts through the air, making a loud humming noise. I gazed intently in the direction of the noise and found that something was coming downward at a rapid rate. I looked, with my hand up, standing in a dodging position, for fear of its striking me, until I saw it strike some willow saplings about 70 or 80 yards from where I was and fall thence to the ground. Upon going to the spot, I found a strange looking rock, nearly buried in the ground and still warm.'

"Major Slass, editor of 'The Alabamian and Times' in this place, has taken considerable trouble to collect all the information he could on the subject. He says 'that the noise was heard for several miles round before the final explosion. It burst, apparently, over the heads of twenty men, who were at work felling wood 1.25 miles from Mr. Hooper's house. One piece appeared to go southeast, another southwest, and the third northwest. There were afterwards heard reports resembling the bursting of shells. One piece was heard to fall some distance from Mr. Hooper's, making a loud crashing noise and frightening a lot of hogs near by.'

"The reports resembling artillery were plainly heard for 20 or 25 miles east and west of Frankfort and from 15 to 20 north. I have no information as to the south. Mr. Hooper deserves much credit for noting the particulars of the fall and for sending the meteorite for analysis and description. He refused with scorn money offers that must have been tempting to a person of limited income, preferring the advancement of science to dollars and cents.

"In a personal interview he told me that he was sitting by a fire with his family when he heard the first noise. He instantly arose and walked 40 or 50 yards from the house before the meteorite fell. His sister, Miss Hooper, living near, called to her brother to 'run quickly, the house is on fire—don't you hear it?' Mr. Hooper thinks it was three or four minutes from the first noise until its fall."

The stone weighed 615 gr. at the time it was secured; and its weight entire could not have been more than 650 gr. It is oblong in form, with rectangular sides. The crust was entire, except for a small corner, although the whole mass seemed to have a fresh fracture running through it. The coating has a very brilliant luster, as bright as if newly varnished, strongly resembling that of the Stannern, Petersburg, Tennessee, and Bishopville stones. It seems to have been in a condition of viscid fusion, as shown by the ridges on the edges. The crust was so thin that the olivine could be distinguished through it in places.

Seen with the naked eye, the fractured surface shows a pseudoporphyritic structure, having a gray ground with black, green, white, and dark gray spots upon it.

Analysis by G. J. Brush and Wm. G. Mixter:

		Oxygen.	
Silica	51.33	26.37	
Alumina	8.05	3.75	
Ferrous oxide	13.70	3.04	
Chromic oxide	0.42		
Magnesia	17.59	7.04	12.28
Lime	7.03	2.06	
Soda	0.45	.11	
Potash	0.22	.03	
Sulphur	0.23		
Nickeliferous iron	trace		
	99.02		

Specific gravity, 3.31.

From this composition it would appear that the mass is probably made up of uni- and bi-silicates, and contains an olivine, a pyroxenic mineral, and a feldspar, besides chromite, troilite, and a very small amount of nickeliferous iron.

It seems to belong to the class of meteorites that Prof. G. Rose calls Howardite, and which he describes as being granular mixtures of olivine, with a white silicate (anorthite?) and a small amount of chromite and nickeliferous iron. This class, according to Rose, includes the stones from Luotolaks, Bialystok, Mässing, Nobleborough, and Manegaum.

Meunier[2] classes Frankfort as a howardite, although he states that Rammelsberg classes it as an eukrite on account of lack of olivine. Meunier, however, states that some specimens show olivine plainly and that all the other characters are those of the howardites.

The stone is distributed, the Yale and Harvard collections possessing the largest pieces (Yale 255 gr., Harvard 127 gr.).

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Franklin County, see Frankfort.

Frederick County, see Emmittsburg.

Fulton County, see Rochester.

Gargantillo, see Tomatlan.

Garret County, see Lonaconing.

Gettysburg, see Mount Joy.

Gilpin County, see Russell Gulch.

Gibbs meteorite, see Red River.

FRANKFORT.

Franklin County, Kentucky.
Latitude 38° 8′ N., longitude 80° 40′ W.
Iron. Medium octahedrite (Om) of Brezina; Thundite (type 19) of Meunier.
Found 1866; described 1870.
Weight, 11 kgs. (24 lbs.).

This meteorite was first described by Smith,[1] as follows:

The Franklin County meteoric iron was first brought to my attention in a blacksmith shop in Frankfort, Kentucky. It was carried there to be tested in regard to its quality as iron; being supposed by its discoverer to indicate an iron mine. Mr. Nelson Alley became possessed of it, and kindly presented it to me.

It came from a hill 8 miles southwest of Frankfort, latitude 38° 14′ N., longitude 80° 40′ W. from Greenwich, and was discovered in 1866. It passed into my possession in 1867, and was then described by me, but the manuscript was lost after its leaving my hands, and the original notes were misplaced; the notes have been recently discovered, and the iron again analyzed.

Its form is somewhat globular, with a highly crystalline structure. Its weight was 24 pounds; and this appears to have been its original weight, only a few flakes having become detached by the rusting through of the fissures. Specific gravity, 7.692. Its composition when perfectly freed from rust and earth is—

Iron	90.58
Nickel	8.53
Cobalt	.36
Copper, minute quantity.	
Phosphorus	.05
	99.52

having, as will be seen, the usual composition of meteoric irons.

Brezina[2] included Frankfort in the octahedrites with medium lamellæ, and gives the width of the lamellæ as 0.1 mm.

Huntington[3] describes a specimen of the meteorite in the Harvard collection weighing 7.260 gr., which shows an octahedral cleavage form. He states that a large part of the surface is covered with a crust and regards the "crystal" as a "fragment of an iron meteorite broken up

after entering the atmosphere, but while still moving rapidly enough to produce a melted crust over the surface of fracture." In his later catalogue, Huntington [4] gives a sketch of this mass. The description and weight hardly agree with Smith's account.

Meunier [5] lists what is probably meant to be this iron as Frankfort, Franklin County, Alabama, 1854. He states that the figures are remarkably well defined and also says:

The tænite is in very narrow plates between tubercular bands of kamacite. The plessite is in extended areas of relatively dark shade and incloses little spots of a silver-white metal which has not been isolated. The museum specimen shows a large nodule of pyrhotite remarkable for its high degree of crystallization and the extreme tenuity of its graphitic coat.

The meteorite is distributed, the largest piece being in the Harvard collection.

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5. 1893: Meunier. Révision des fers météoriques, p. 61.

GLORIETA.

Glorieta Mountain, near Canoncito, Santa Fe County, New Mexico.
Here also Albuquerque and Canoncito, but not Canyon City or Trinity County.
Latitude 35° 34′ N., longitude 105° 45′ W.
Iron. Medium octahedrite (Om) of Brezina; Caillite (type 18) of Meunier.
Found and noticed 1884; described 1885.
Weight about 146 kgs. (320 lbs.). Sixteen individuals, of which the three largest weighed 67.52 kgs.

This meteorite was first described by Kunz[1] as follows:

This mass was found by Mr. Charles Sponsler, a prospector, on some unclaimed land on Glorieta Mountain about half a mile from a house in the woods 1 mile northeast of Canoncito, Santa Fe County, New Mexico, in May (?), 1884. The mass was lying on a rock, upon which it had fallen, in three fragments, and judging from the few marks of weathering had not been long exposed. The exact date of discovery not determined.

The weight of the entire mass is 317 pounds (143.76 kg.). Perhaps 1 kg. had been chipped off, so that the original weight may have been about 145 kg. The dimensions of the original mass were approximately 25 by 10 by 15 inches (65 by 25 by 37 cm.). It is quite unusual to find so large and compact a mass of iron so completely broken asunder, and in this respect the fall is unique. The fractures are very clean considering the size of the fragments, although the edges are somewhat irregular. No. 1 is filled with elongated hollows, proving that it evidently was disturbed, and the twistings in No. 2 at the point of impact would lead to the conclusion that the falling body was partly semiplastic; but Professor Thurston compares the fracture to the effect of a sudden heavy blow on cold iron as may be seen in an iron target used for heavy gun practice.

No. 1 weighs 148.5 pounds. About one-third of the whole surface shows the disjuncture very plainly, as also the exact point where this began. This mass measures 39 by 30 by 22 cm. One part has a peculiar bubbled pasty appearance as if the mass had been cooled in water at this point. Some of the pittings are 5 cm. across and quite deep and well marked. An etched surface of this fragment shows the Widmannstätten figures.

No. 2 weighs 115 pounds (52.38 kg.) and measures 41 by 24 by 16 cm. About one-third of the surface of this piece shows the remarkable rupture, the remainder being covered with the pittings. On one corner there is a portion 10 by 6 inches which is evidently the spot where the mass struck the rock. Here the pittings are flattened and the whole mass distorted and curled over, giving it a radiated or fanlike appearance.

No. 3 weighs 53.5 pounds (24.263 kg.), and measures 30 by 21.25 by 15 cm. Over five-sixths of the entire surface is pitted, some of the depressions being 5 cm. across and nearly 2 cm. deep. The place of rupture is plain and the iron here is coarsely fibrous, possibly because it was farther from the point of impact. There is also a fissure 10 cm. deep and nearly 1 cm. wide opposite the broken face. In this fissure are fragments of two chisels which were broken in the attempt to pry off this piece and which may have enlarged the opening.

This iron is one of the Holosiderites of Daubrée, and comes under the general group of Cailite of Meunier; it is related to the irons of Augusta County, Virginia, Whitfield County, Georgia, and Washington County, Wisconsin. The iron is of the characteristic octahedral structure, and the Widmannstätten figures are made up of kamacite (Balkeneisen or beam-iron), i. e., iron with little nickel, enveloped in tænite (Bandeisen), rich in nickel and plessite (Fülleisen). On a single section one field of dark plessite measured 17 by 8 mm., the kamacite from 0.5 to 0.2 mm. in breadth. The tænite was abundant and brilliant.

Analysis of No. 3 by J. B. Mackintosh:

Fe	Ni	Co	P	
87.93	11.15	0.33	0.36	=99.77

Specific gravity of No. 2 about 7.66+.

Troilite was observed on the crust of No. 1, also traces of olivine and perhaps schreibersite.

Later Kunz [3] gave an account of the discovery of additional masses and further notes upon them as follows:

During the month of August, 1885, Mr. J. H. Bullock thoroughly examined and dug over the ground, working about six weeks steadily, and was rewarded by finding three more masses of the Glorieta meteorite (Nos. 4, 5, and 6). In the meantime a Mexican had also found a small piece (making seven fragments thus far obtained), but it disappeared before Mr. Bullock could secure it. Mr. Bullock states that the pieces found by Mr. Sponsler were discovered while he was prospecting during the month of August, 1884, on the ranch of Mrs. Roival near Canoncito, Santa Fe County, New Mexico, 5 miles from the summit of Glorieta Mountain.

No. 4 weighs 1.204 kg. (2.65 pounds). One-third of the surface shows the disruption as in No. 2, the other parts being unaffected and showing the crust surface. The broken surface is partially drawn out toward the part that was torn off from it, and one edge shows a fracture suggesting cleavage. The mass is 50 mm. high, 125 mm. long, and 50 mm. wide, or about 2 by 5 by 2 inches. One of the pittings which has been increased in size by the disruption measures 60 mm. in length, 25 mm. in width, and 15 mm. in breadth.

No. 5 weighs 1.126 kg. (2.48 pounds), measures 100 mm. in length, 75 mm. in width, and 48 mm. in height, about 4 by 3 by 2 inches. Five-sixths of the entire surface bears the marks of violent disruption; the mass was undoubtedly broken from the upper corner between Nos. 1 and 3. A raised octahedral structure, resembling a coarse network, is revealed on two-thirds of its surface and the pitted side shows evidence of having received a part of the blow.

No. 6 weighs 1.05 kg. and measures 125 mm. in length, 82 mm. in width, and 45 mm. in thickness at the thickest part. It is quite flat, the fracture having left a surface so flat as to be suggestive of a cleavage. Altogether this mass closely resembles No. 4.

The 148.5-pound piece (No. 1) was found only 8 feet from the 115-pound (No. 2) and the 53.5-pound (No. 3) pieces, while the small pieces picked up by Bullock and the Mexican were 45 or 50 feet from the large mass, being hurled farther on account of their lightness. The fact that the pieces lay so near together proves conclusively that the meteorite did not burst in mid-air. The pieces were all embedded in the vegetable mold which covered the rock at that place, the largest piece to the depth of 10 inches.

Nearly the whole of the large mass (No. 1) has been cut into slices. The iron is seen to be very homogeneous throughout with the exception of an occasional space measuring 1 mm. to 4 mm. across. One of these spaces near the center of the mass was evidently formed by the shock of disruption. In a few instances this explanation is verified by the curving of the Widmannstätten figures, showing that nearly every part of the thick mass was twisted and wrenched when it burst asunder with such tremendous force. The ruptured surface on Nos. 1 and 3 shows large patches of troilite. In cutting No. 1 large streaks of this mineral and also some schreibersite were observed. The largest of these lines of troilite was 10 cm. long and 4 mm. wide. Two of the streaks, 10 cm. apart, ran parallel to each other in peculiar crescent-like formations. Olivine was observed at the upper end of No. 1, a surface of about 10 cm. square being completely filled with it. The color in some instances was a rich brownish yellow, homogeneous throughout, and as compact as in the "Pallas iron." The largest grains observed measured from 8 mm. to 14 mm. Some of these pieces yielded perfect transparent gems (peridots) over 4 mm. in width.

The discovery of a seventh mass regarded as silver bullion and sent from Albuquerque was described, as well as the mass itself, by Eakins [2] as follows:

A seventh mass, found near Albuquerque, New Mexico, is referred to this fall. It was mistaken for silver by the finder. Originally of triangular shape, it measures 120 by 80–100 by 45 mm. Before cutting it weighed 2.5 kg. When found it was covered with a thin oxidation coating. The iron composing this meteorite is exceedingly tough and free from cavities. The etched surface shows very well-defined Widmannstätten figures.

Analysis:

Fe	Ni	Co	Cu	Zn	C	Mn	P	S	Si	
88.76	9.86	0.51	0.034	0.030	Undt.	trace	0.182	0.012	0.044	=99.432

Composition:

Nickeliferous iron	98.224
Troilite	.033
Schreibersite	1.175
	99.432

Cohen and Weinschenk [6] studied several features of the meteorite as follows:

Of Glorieta Mountain three pieces were investigated; two from the Greifswald collection, the third from the Vienna collection. The Vienna material was slowly soluble in dilute HCl, that from Greifswald was hardly attacked, doubly concentrated acid being necessary to affect it, and this at first only weakly, but after some time more uniformly.

For the solution of a piece weighing 17 gr. over 9 weeks were necessary. These differences of behavior could be ascribed not to chemical or structural distinctions, but to crystallographic orientation of the sections, causing in one case more tænite and in the other case more kamacite to appear at the surface. The kamacite on treatment by acid became black, and the acid worked especially rapidly on the swathing kamacite, which inclosed a great schreibersite crystal of which a piece could be separated in sufficient quantity for a chemical investigation. The plessite was also soon attacked, so that the combs became prominent after short treatment with the acid.

	I 17.641 gr. With 1 HCl+10 aq.		II 44.528 gr, With 1 HCl+10 aq.		III 82.36 gr. With 1 HCl+20 aq.	
	gr.	%	gr.	%	gr.	%
Solution of nickel-iron	16.2971	92.38	40.5929	91.16	68.6063	83.30
Tænite	0.8711	4.94	2.8506	6.40	3.5851	4.35
Schreibersite	0.4728	2.68	1.0845	2.44	6.4808	7.87
Swathing kamacite	------	------	------	------	3.4711	4.22
Rust	------	------	------	------	0.1537	0.18
Carbon substance	------	------	------	------	0.0630	0.08
	17.6410	100.00	44.528	100.00	82.3600	100.00

Numbers I and II left no marked carbonaceous residue, and as this was small in quantity in number III also it was evident that Glorieta Mountain is relatively poor in carbon. The carbonaceous substance from number III after heating and treatment with hydrochloric acid and sodium hydrate left only two to three angular, colorless, doubly refracting grains. The schreibersite in number III, composed of 5.5 gr. of large crystals which were aggregated together, was easily dissolved from the surrounding nickel-iron. Both lots of schreibersite were alike in physical properties. The lack of jagged pieces indicated that the tænite lamellæ lay close together, and hence longer treatment with acid was required to separate them.

Tænite.—Especially characteristic of the tænite from Glorieta Mountain is the union of the foliæ in bundles. After the thin intermediate kamacite plates were completely dissolved out a skeleton remained about 4 mm. thick and 1.33 cm. long. The kamacite represented, therefore, only a very small surface of attack, and it was difficult, as in all the other irons investigated by us, to obtain pure tænite. Even when the bundles seemed completely separated and small leaves of about 0.15 mm. thickness isolated it was evident that many thin lamellæ lay packed together. Through the uneven, thin wavy surface the usual luster could be observed, also elasticity and color.

The analyses of the material dissolved in acid gave the figures under I, while in Ia the schreibersite corresponding to the phosphorus is calculated:

	I	Ia
Substance taken	0.2563	------
Fe	63.22	63.04
Ni	35.56	35.53
Co	1.39	1.43
P	0.56	------
Cu	0.00	------
C	Trace.	------
	100.73	100.00

Schreibersite.—For chemical investigation, the above-mentioned large crystals were chosen, the physical properties evidently being somewhat different from those of Toluca. They are brittle and almost without exception fall apart on standing. The characters resemble those of bodies with strong tension, such as diamonds and bologna tears. Any unaltered crystals were, therefore, not to be had. Where crystal faces appear they show little glancing facets, like those of Toluca. Cleavage in three perpendicular directions is exhibited, with conchoidal fracture. One cleavage is like that of galena; the other two seem to be equal and somewhat less perfect than the first. The surface of the crystals often seems finely striated and not so smooth as Toluca. Color, tin-white to gray, luster like to coal, streak gray.

The analysis gave:

Substance taken	0.4086		
P	15.49	: 30.96 = 0.5003	= 0.5003
Fe	63.36	: 55.88 = 1.1339	= 1.4899
Ni	19.63	: 58.60 = 0.3560	
Co	1.23		
	99.71		

Fe : Ni (Co) : P = 2.2664 : 0.7116 : 1

Fe+Ni (Co) : P = 2.9780 : 1

Although the physical properties differ somewhat from the large schreibersite from Toluca, the chemical composition is so similar as to indicate two analyses of one and the same substance.

Swathing kamacite.—The natural surface of the plate 1.7 to 2.3 mm. thick showed, especially on the boundary toward the schreibersite, conchoidal depressions. One recognizes in the latter the impressions of the rounded faces of the large schreibersite crystals which are thus doubtless older. The swathing kamacite has the hardness of steel, is very tough, tin-white grading to silver-white, and easily soluble in hydrochloric acid. In contrast to the schreibersite and tænite it does not oxidize quickly. This is remarkable since the nickel-poor compounds usually oxidize more easily than the nickel-rich. Under I follows the result of the analysis; under Ia the composition after removal of the schreibersite and calculation to 100.

	I	Ia
Fe	93.77	92.62
Ni	6.66	6.55
Co	0.84	0.83
P	0.02	.....
C	Trace.	.....
Cu	0.00	.....
	101.29	100.00

The composition is thus like that of the normal kamacite and further analyses are needed before one can decide whether the swathing kamacite contains a somewhat higher content of nickel and cobalt.

Meunier [9] remarks as follows regarding the troilite of the meteorite:

The pyrrhotine sometimes occurs in a peculiar manner, filling the angular spaces left by the apparent cracking of the mass, which left open spaces as receptacles for the sulphurous emanations.

Brezina [11] gave the following account:

This iron is, like Butsura, an example of a meteorite which burst before reaching the earth and suffered partial fusion after separation of the pieces. Of the nine hitherto known individuals of this fall, of 67.4, 51.7, 24.3, 1.2, 1.1, 1.0, and 2.5 kg. weight, also two small individuals of unknown weight, there are in our collection four complete and three complete sections obtained at one time. All are highly oriented; the three larger ones have remains of the fusion crust in many places, and always only on the same side, which, from the rounded appearance of the surface elements, gives evidence of being the primary face, while the side characterized by its hackly fracture as the recent, secondary face, presents no fusion crust. This condition is distinctly noticeable on the second largest specimen of the fall (51.7 kg.). Upon the side having the primary surface, which also bears the apex of the total mass, the streaks spread out like disheveled hair, and this is true not only of the fusion crust but also of the underlying iron particles, running over the side margins in puffy ridges. Kunz supposed that this phenomenon was caused by the forcing of the meteorite through the sand in its fall. The three small individuals of 1.0 to 1.2 kg. weight have a highly oriented form, while on each is to be distinguished a convex face covering almost half the exterior of pronounced primary character, with very flattened forms and a row of secondary facets of a hackly, slightly fused fracture. These three individuals had lain in a loamy soil strongly charged with iron and still bore much of this material upon them. The latest, just recently discovered piece, is much rusted and has the form of a splinter of iron 30 cm. long by 8 cm. in thickness, which, like all other individuals of this fall, has upon one side a primary surface and upon the other a more or less secondary surface. Very unique formations may be seen on the section of the seventh find of this fall; it is a triangular plate of 109 gr. weight. Of the three small facets one is concave and possesses a pronounced primary character, considerably flattened and with remains of the fusion crust; the other two facets are, with the exception of the portions adjacent to the concave face, decidedly secondary, hackly, and withal slightly convex. Along the primary surface portion may be seen a zone of alteration 1.2 mm. wide, while the secondary face for the most part is bordered with bands of enveloping kamacite, which in the Glorieta iron usually incloses the strongly developed octahedral schreibersite plates. The Widmannstätten figures show an extensive, extremely regular bending of the whole mass, which reaches a total amount of 65°. As a result, the ends of the primary faces are bent inward (concave), hence the secondary faces are bent outward. The texture of the Glorieta iron, as shown by the etched surface, is a very mixed one, because of the alternation of coarse and fine structure. The bands are mostly very long, up to 12 and 15 mm., more or less notched, straight, or bent with the entire iron, behind the dominant areas mostly inconspicuous; tænite normally developed; fields predominating, mostly filled with repetitions of the longer bordering bands, sometimes comb-like with both such border bands or with dark-gray plessite, or finally with two or more such fillings. The kamacite is very resistant to acids, and is coarsely flecked. Numerous schreibersite laminæ, often as much as 10 cm. long, sometimes show crystalline borders and are enveloped in kamacite bands 2 mm. broad, which also inclose accompanying troilite nodules. The rupture of the piece has occurred for the most part along such laminæ of schreibersite. The border kamacite clinging to the edges of a piece then often appears like a zone of alteration. On a small end-piece of the largest mass the entire natural surface is lumpy like kneaded dough and a zone 1.5 to 3 mm. thick, resembling border kamacite, runs around the section surface. Grains of cohenite seldom occur in the kamacite. Glorieta has many points of similarity in structure with Joe Wright. Here also belongs, apparently, the Canon City meteorite, published by Shepard.

In this last opinion Brezina is in error, as was shown by Ward (see Canyon City).

Cohen [12] made determinations of the magnetism and specific gravity of the meteorite.

Brezina [14] gives two cuts of an oriented individual weighing 492 gr. The form is much elongated.

The meteorite is distributed, Vienna possessing 60,778 gr., Paris 21,740 gr.

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GRAND RAPIDS.

Kent County, Michigan.
Here also Walker township.
Latitude 42° 58′ N., longitude 85° 41′ W.
Iron. Fine octahedrite (Of) of Brezina.
Found 1883; described 1884.
Weight, 51.5 kgs. (114 lbs.).

The first account of this meteorite was by I. R. Eastman [1] as follows:

While staying over Sunday in the city of Grand Rapids, Michigan, in September, 1883, I saw in a local newspaper a reference to a strange, heavy metallic mass which was to be seen in the store of Mr. C. G. Pulcher. Early Monday morning I found the store and immediately recognized the meteoric character of the mass.

It was roughly pear-shaped, 14 inches long, and 9.6 inches in diameter at the thickest part, and weighed 114 pounds. It was discovered about May 15, 1883, by Michael Clancy, a contractor, while making an excavation for building purposes on land belonging to the Catholic Church in Grand Rapids. It was found about 3 feet below the natural level of the ground and wedged between two large bowlders, and was removed with considerable difficulty. The finder feeling certain that he had secured a valuable prize kept his secret for some weeks and expended much time and labor with hammer and cold chisel in the attempt to cut off the smaller end. He succeeded, however, only in mutilating the unusually fine specimen by cutting a groove about three-sixteenths of an inch deep quite around the mass and 6 inches from the smaller end.

Mr. Pulcher could not then be induced to part with the mass, but I finally secured a few grains in weight from the bur left by the chisel, from which Mr. F. W. Taylor of the Smithsonian Institution made a preliminary analysis of a specimen weighing 24 grains with the following result:

Fe	Ni	Co	Insoluble residue	
94.543	3.815	0.396	0.118	=98.872

The fragment was somewhat oxidized, which accounts in part for the shortage. The entire specimen is now in the Smithsonian Institution for examination and analysis.

Riggs [2] reported a further analysis as follows:

In a recent number of this journal I. R. Eastman describes a meteorite found in Grand Rapids, Michigan. A preliminary analysis was made at the time, but of a very inadequate amount of the oxidized material, taken from the surface. Since then the meteorite has come into the keeping of the U. S. National Museum and a more complete analysis gives the following results:

Fe	Ni	Cu	Mg	P	S	C(combined)	Graphite	
88.71	10.69	0.07	0.02	0.26	0.03	0.06	0.07	=99.91

It is a mass of great apparent homogeneity, weighing originally about 50 kg. One of the sections, however, on being polished discloses a nodule about 1 cm. in diameter, like troilite in appearance, which remains to be investigated. A polished surface of the meteorite etched with nitric acid developed very handsome Widmannstätten figures, somewhat like those on the iron from Robertson County, Tennessee.

Meunier [3] described the iron as a heterogeneous one showing many black particles.

Brezina [4] described the Vienna specimen as follows:

This mass shows the most marked grouping of the lamellæ into bundles of any iron yet observed. Bands 0.3 mm. wide, long and straight, somewhat puffy, kamacite medium fine, somewhat lightly hatched and grained; tænite normally developed; fields now abundant, and now inconsiderable, filled with gray, half blended, fine repeating lamellæ, occasionally giving the appearance of staining or spotting. Reichenbach lamellæ are abundant and surrounded by borders of kamacite. On one piece a globule of troilite 12 mm. in size was noticed, with a border of kamacite 1 mm. in thickness which showed a tongue of iron projecting into the interior of the troilite to a depth of 2 mm. There is also a zone of alteration along the natural surface 0.2 to 0.5 mm. wide, which runs quite even on the inside despite the wavy character of the outer surface.

Cohen [6] essentially repeats the characteristics given by Brezina as follows:

The bands are long, straight, somewhat puffy, usually bunched and then strongly, the tænite borders are not very prominent, the fields are well developed and distinctly marked off from the lamellæ. The kamacite, slightly granular in places, shows many sharp etching lines and appears under very strong magnification to be exceptionally finely punctate, apparently in consequence of tiny, closely and evenly distributed etching pits. It also exhibits a strong oriented luster. The smaller fields consist of compact very dark plessite with tiny glistening scales. In the more extended fields the latter are larger (0.005 mm. in diameter with limits of 0.003 and 0.01 mm.) and while they are so arranged that the stripes which intersect one another appear now darker and now brighter it appears under the glass as though such fields were composed of bands; under stronger magnification it becomes apparent that this is not the case, since the stripes are in no way distinguishable from one another. These are probably Brezina's "gray, half shaded, fine repeating lamellæ." Occasionally there occurs in such a field a complete lamella about 0.04 mm. thick, isolated in such a way that a union with the large bands and their tænite envelope is at least not perceptible, or else the field is traversed by a bundle of such lamellæ whose tænite envelope then, however, differs from the principal tænite.

Grand Rapids belongs to the few meteorites which take on no permanent magnetism. Leick determined the specific gravity at 7.8862 and the specific magnetism at 0.12 absolute units per gram.

The meteorite is distributed.

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Green County. See Babbs Mill.

GREENBRIER COUNTY.

Summit of Alleghany Mountains, 3 miles west of White Sulphur Springs, West Virginia.
Here also Alleghany Mountains and White Sulphur Springs.
Latitude 37° 49′ N., longitude 80° 26′ W.
Iron. Coarse octahedrite (Og), of Brezina.
Found about 1880; mentioned 1885 or earlier in a London catalogue; described 1887.
Weight about 5 kgs. (11 lbs.).

The meteorite has been chiefly described by Fletcher,[2] as follows:

A single fragment of iron having an estimated weight of 11 pounds was found about the year 1840, on or near the top of Alleghany Mountains, 3 miles north of White Sulphur Springs, Greenbrier County, not far from the eastern border of West Virginia (latitude 37° 51′ N., longitude 80° 20′ W.). The finder, and his official agent, thinking it a rich piece of iron ore, searched unsuccessfully for a vein. The specimen itself was taken to a country blacksmith, heated, and cut with a cold chisel, and pieces distributed as specimens of iron ore. Some time afterwards two of them, weighing 63 and 31 ounces, were given by the agent to Mr. Matthew A. Miller, C. E., of Richmond, Virginia. Convinced of their meteoric origin, he immediately tried to recover the pieces already distributed, but after traveling several hundred miles, he was forced to the conclusion that they were irrevocably lost. From Mr. Miller the two pieces were acquired for the British Museum.

In shape they are irregular; each of them presents clear evidence of being fragmentary, the surface being partly smooth and pitted and partly jagged, the latter showing in a remarkably distinct way edges, faces, and crevices which belong to an octahedral structure. Specific gravity, 7.869.

The polished surface is immediately active in the presence of a solution of copper sulphate. The iron is extremely soft and is easily cut into slices with the saw. On the polished faces of these slices no stony minerals are visible, but there are seen sections of a few rounded cavities, of which the contents have a grayish-black color and a metallic luster. This material is principally composed of finely divided iron which has perhaps been worked into the cavities during the sawing of the specimen and the subsequent leveling of the surface. The rest is graphitic carbon, which may have been sufficient to fill the cavities when the specimen was intact. No chromite was found in the cavities.

During the polishing of one of the sections a part of its surface was bent inwards and an empty cavity with plane faces was discovered. The quadrilateral bit (?) of the cavity is 6 by 3 mm.; three of the edges of the section of the cavity were seen to be parallel to structure lines visible on the polished surface even before etching; the sides of this cavity were rusty. Similar cavities are found in the iron of Rancho de la Pila, Durango, Mexico.

The polished and etched surface yields very distinct Widmannstätten figures. On a section not very much inclined to an octahedral face the beams of kamacite vary from 0.8 to 1.2 mm. in width. They have straight edges, are arranged in groups, and are sometimes continuous for a length of 17 mm. They are separated by very thin layers of tænite. Plessite is plentiful, but is very homogeneous in structure and not very different in appearance from the kamacite. There is no oriented sheen, such as is presented by the etched surfaces of many meteoric irons. The etching figures and the composition of this iron resemble those of Staunton, Virginia.

Chromite in the form of a fine powder, small fragments, a thin elongated plate, and a single crystal of very fragile character were found in the insoluble residue of the analysis:

Fe	Ni	Co	Cu	P	S	Residue	
91.59	7.11	0.60	trace	0.08	trace	0.12	=99.50

The above percentage composition is approximately that of the Trenton, Rio Juncal, Seneca River, and Staunton irons.

As stated by Fletcher, the known pieces of this iron are chiefly in the British Museum (2,236 gr.).

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Guernsey County. See New Concord.

GUILFORD COUNTY.

North Carolina.
Latitude 36° 4′ N., longitude 79° 48′ W. (approximate).
Iron. Medium octahedrite (Om), of Brezina.
Described 1822.
Known weight 200 gr. (7 ounces).

This mass was first described by Shepard [2] as having been obtained from Professor Olmsted, of North Carolina. It was one of two pieces of iron, the larger of which was briefly described in the catalogue of Olmsted's collection.[1] The locality of the smaller piece Professor Olmsted stated to be "Guildford" County, 10 or 15 miles distant from the locality of the larger specimen which was found in Randolph County. The individual from whom Professor Olmsted obtained it told him that it had been detached from a large mass weighing 28 pounds, some of which had been worked by a blacksmith into horseshoe nails. The piece preserved is described by Shepard as weighing 7 ounces and as being a distinct crystal in the form of an octahedron. The axis of the crystal, he says, measures 3 inches, and the structure is distinctly foliated, the laminæ being pretty uniformly one-twentieth of an inch in thickness.

Later, Shepard [3] made an analysis of the iron—specific gravity, 7.67 (Rumler)—with results as follows:

Fe	Ni	FeS	
92.750	3.145	0.750	=96.645

Brezina [14] groups Guilford County with Toluca, and describes it as having small, slightly puffy lamellæ, 0.5 mm. wide.

The small quantity of the iron known is distributed.

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Hacienda de Bocas, see Bocas.

Hacienda Concepcion, see Adargas.

Hamblen County, see Morristown.

Hamilton County, see Carlton.

HAMMOND.

St. Croix County, Wisconsin.
Here also Saint Croix County.
Latitude 44° 58′ N., longitude 92° 38′ W.
Iron. Hammond group of octahedrites (Oh), of Brezina.
Found 1884; described 1887.
Weight, 24 kgs. (53 lbs.).

The first account of this meteorite was by Fisher,[1] with a note by Kunz, and was as follows:

The mass of meteoric iron described in this paper was ploughed up three years ago (1884) in a cornfield on the farm of Mrs. Jenette Rattary, in Hammond Township, St. Croix County, Wisconsin. (The exact description of the 40 acres is: N. ½ SW. ¼ Sec. 31, T. 29 —., R. 17 W.)

It attracted attention from its weight and silvery luster where freshly abraded, and was supposed to contain silver, but its real nature was not suspected, and it lay about the farmyard until last winter. At that time, during the excitement about iron ores in that neighborhood, a speculator chanced to see it and he at once paid $50 for an option on the 40 acres to prospect for iron ore. The mass was sent to me for analysis, and on its being reported to be a meteorite was reclaimed by the owner, and it was not until I visited the region in May last that the facts of its discovery were ascertained.

It was struck by the plow near the surface of the ground in a field that had been cultivated for corn for several successive years, and the farmer was quite certain that it could not have been there the year before, and its fresh appearance noted later, testifies to the probability of its having recently fallen. It is quite remarkable that it kept so bright during the three years it lay in the farmer's yard. No similar pieces have been seen, nor does this show signs of fracture.

The mass has been considerably disfigured by attempts to chisel off pieces at different points, and one piece was detached and forged into a spike, but this I did not see. When it reached me, it weighed 53 pounds (24 kg.). It is of irregular shape, as shown in an accompanying cut, engraved from a photograph I had taken when it first reached me.

Its dimensions are 8 by 8 inches across the face and 7 inches through, in the thicker part, but with an average thickness of 4 to 5 inches. The back side, as the view is taken, is nearly flat and pretty uniformly covered with circular pittings. On this side, it presents the ordinay appearance of most masses of meteoric iron, the surface crust having entirely disappeared. It seems probable that it lay with this surface in contact with the ground during the three years after it was dug up, and the crust disappeared by the ordinary process of weathering. The front side is less regular in shape and shows several large depressions. This surface is largely covered with the fused crust, which is heaped up in ridges and shows all the perfections of the lines of flow characteristic of irons which have been picked up immediately after their fall; the only change being a partial oxidation of this film so that it appears in places brown instead of black. This character of the St. Croix meteorite, independent of the confirmatory evidence afforded by the circumstances of its history, would make it probable that its fall did not precede by many months the date of its discovery.

A careful analysis of the iron was made by the writer and his assistant, Mr. Charles G. Allmendinger, with the following results:

Fe	Ni	Co	P	S	C	Cu	Sn	
89.78	7.655	1.325	0.512	0.562	traces	traces	traces	=99.834.

Specific gravity: First, 7.601; second (on two different pieces), 7.703.

It contained nodules of troilite, three appearing in one section, from 3 mm. to 12 mm. in diameter. No other inclosures were detected by me.

I am indebted to Mr. George F. Kunz for sections cut from the mass and polished for etching, and I leave to him the description of the Widmannstätten figures, etc. The meteorite now forms a part of the collection of Yale University at New Haven.

NOTE BY MR. GEORGE F. KUNZ.

When dilute nitric acid is applied to the St. Croix County iron, the Widmannstätten figures quickly appear, but unlike the Glorieta and Staunton meteorites, it could not be etched to any depth, because on long continued application of the acid, the entire surface of the iron rapidly dissolves away, leaving only projecting points of tænite. Hence it was found impossible, as had been at first intended, to reproduce the figures directly from an electrotype taken from the iron. The figures are cubical rather than octahedral in arrangement and more closely approach the Jewellite group of Meunier, particularly the Dickson County iron. In form the entire arrangement resembles the Schwetzite, Werchne-Udinsk, Siberia group, but the figures are about one-third their diameter. It also resemble. somewhat the Trenton, Wisconsin, iron, but still differs from all of those. Troilite is present in nodules 5 to 10 mm. in diameter and also filling the irregular fissures some 50 mm. long and 1 to 3 mm. wide.

In 1893, Brezina[2] made of Hammond a subspecies of octahedrite, to which he gave the name Hammondite, and which "instead of the tænite border around the kamacite lamellæ, has fine granular particles of a plainly carbonaceous substance which turns black by etching, arranged in curvilinear plates." In 1895, he described[3] the structure more in detail as follows:

Lamellæ long, somewhat irregularly oriented. 0.35 mm. wide, bunched and much bent, much less prominent than the fields. Band iron (if one can speak of such here) bright gray, slightly dotted and bordered with dustlike granules, apparently belonging to a carbon compound, which turn dark gray by etching and which are arranged in rows. The fields are filled with half shaded combs or with an iron which is more dotted and therefore darker in color than the kamacite. In several places isolated swathing kamacite is found, 2.4 cm. long and 1 mm. broad, surrounded with a dustlike sheath consisting of brightly glistening grains of schreibersite in combination with troilite-schreibersite concretions 1 cm. in size. The bands bear many granular inclusions resembling cohenite. Along the natural surface there is an alteration zone from 1 to 2 mm. in width.

Klein[5] described the meteorite thus:

It shows pretty streak inclusions in pipe-form. The iron is intersected with bands of dull and compact iron, which contain glistening iron with cohenite inclusions. This dull variety of iron radiates from an inclusion in a sixfold form, and each branch contains in its center a dark layer (cohenite), surrounded and penetrated with bright iron.

Cohen[4,7] described the structure as follows:

Observed with the naked eye an etched section shows great similarity to an octahedrite. Small, elongated particles of light gray, glistening nickel-iron, which intersect one another nearly at right angles and resemble band iron, are found. A duller, somewhat darker nickel-iron fills up the gaps and appears, therefore, similar to the plessite. Small dark-gray seams which surround the latter (nickel-iron?) may upon cursory examination be regarded as the representative of tænite, from which, however, it is sharply distinguished by the fact that it envelopes not the bandlike, but the fieldlike portions. Dark-gray, rounded, short, staff-shaped, or elongated particles of exactly the same appearance as that of the above seams occur also inside the light-gray nickel-iron, dividing the latter into small strips.

By closer examination under strong magnification, or, still better, in reflected light under the microscope, it appears that the nickel-iron as a whole is composed of grains, which in the brighter parts are somewhat coarser than in the darker, and that the above distinguished parts are in nowise separated from one another as in the case of the "Trias" in octahedrites.

In the lighter lamellælike particles the irregular, jagged grains are about 0.02 to 0.04 mm. in size; in the darker, dull, plessitelike portions they are only one-fourth as large, and in the fine, dark-gray seams they are still finer, so that here the individual grains are not distinctly marked from one another. Where this is the case, it is distinctly apparent that each grain is surrounded with a dull, black, somewhat sunken zone 0.005 mm. wide, which apparently consists of nickel-iron more readily attacked by acid. The same forms a fine, black network, whose now coarser, now finer meshes are filled with light nickel-iron. Since the threads are all of approximately the same breadth, they come out the more prominently the smaller the meshes are, and therefore the parts of finer structure appear darker than those of coarser structure. In the latter, the grains are large enough to show that they all have a uniform reflection and that by weak etching they acquire a smooth surface, and by stronger etching they acquire an uneven and therefore less lustrous surface. The dark network may, from its appearance, be composed of nickel-iron richer in carbon than that of the grains; however, it can scarcely be an iron carbide of the composition of cohenite, since the analysis gave a carbon content of only 0.06 per cent.

Since the structure is not composed of lamellæ of different composition, we can not speak of a normal octahedrite. But it is, nevertheless, very apparent that the faintly defined edges of the particles, which are distinguished by color and size, are actually, as Brezina conjectured, oriented according to the octahedral surfaces. In a specimen which I examined, having two sides perpendicular to one another, every portion intersects its fellow nearly at right angles, and then the ensuing figure resembles that of an octahedrite sectioned parallel to a hexahedral face; in other places, however, they seem to be oriented irregularly to one another. As in the case of Cacaria the structure may be best described as an individually streaked one.

Schreibersite is abundant and occurs in various forms, but is more abundant in the more coarsely constructed portions. Here one meets with small scales or grains up to 0.25 mm. in size, which are occasionally arranged in straight lines. Large, irregular individuals are fewer in number; in the case of the longer forms they arrange themselves in aggregations of from 1.5 to 2 cm. in length so that the crystals remain perpendicular to a more or less bent axis. Such a feather-shaped formation I have nowhere else observed in meteoric iron. The schreibersite is without exception surrounded by a broad, dark, very fine-grained envelope which appears to be identical with the above-mentioned dark border of the fieldlike particles. In this border there is, in connection with the larger individuals and the aggregations in their totality, a broad zone of somewhat coarser grain and therefore of lighter color than the rest of the nickel iron, since the size of the grains is from 0.05 to 0.15 mm. The tolerably frequent elongated, irregularly bounded cavities are due to the weathering out of feather-shaped aggregations of schreibersite such as may often be seen in the still remaining residue. Brezina's observation of troilite intermingled with schreibersite I was unable to verify.

Hammond appears still to possess the original fusion crust, although it is almost completely altered to iron hydroxide. That no considerable portion of the nickel iron has scaled off is indicated by the presence of the 1.5 to 2.5 mm. wide alteration zone which shows up distinctly immediately upon weak etching. It compares in color and grain with the dark streaks.

It is noteworthy that two section surfaces on the same piece at right angles to each other each take a different polish. One becomes quite even and of a uniformly bright luster; the other uneven, on account of numerous small pittings, so that it appears as if covered with pin pricks. Their origin can not be determined with certainty, but I think that they are due to the breaking out of small particles of schreibersite in the process of polishing. If this is the case it would indicate a definite orientation of the schreibersite particles.

Analysis by Fahrenhorst:

Fe	Ni	Co	Cu	Cr	C	P	S	Cl	
91.62	7.34	1.01	0.04	0.01	0.06	0.52	0.01	0.01	=100.62

Composition:

Nickel-iron	96.59
Schreibersite	3.36
Daubreelite	0.03
Lawrencite	0.02

The variable and always low specific gravity (7.288–7.506) can be accounted for only by the supposition that there were cavities in the interior of the piece.

The meteorite is almost wholly (23,640 grams) preserved in the Yale collection.

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HARRISON COUNTY.

Indiana.
Latitude 38° 20′ N., longitude 86° 10′ W.
Stone. Howarditic chondrite (Cho) of Brezina; Montrejite (type 38, subtype 1) of Meunier.
Fell 4 p. m. March 28, 1859; described 1859.
Four stones whose total weight was 700 grams (1.5 lbs.).

This fall has been almost wholly described by Smith [1] as follows:

Having become acquainted with a remarkable phenomenon accompanied with a fall of stones that occurred in Harrison County, Indiana, I immediately made inquiries concerning it, expecting to visit the neighborhood on an early occasion; but I was fortunate enough to learn of some admirable observations made by Mr. E. S. Crosier, and in fact so complete were his examinations that I clearly saw no additional information could be elicited by my resorting to the spot. Mr. Crosier obtained for me the various stones that had been found, and also put himself to much trouble to obtain the information desired. The stones fell on Monday, March 28, 1859, and Mr. Crosier visited the place on the Saturday following; in the meantime the following stones were discovered:

1,	weighing	19	ounces,	discovered by	Goldsmith.
2,	"	4.5	ounces,	"	Crawford.
3,	"	420	grains,	"	Lamb.
4,	"	167	grains,	"	Mrs. Kelly.

The following are the facts elicited by inquiry on the spot:

The time at which this fall occurred (4 p. m.) rendered it readily observable. The area of observation was about 4 miles square, and wherever persons were about in that area the stones were heard hissing in the air and then striking on the ground or among the trees.

Hardly a single person in the immediate vicinity of the occurrence saw any flash or blaze, as was noticed by all who heard the report from a distance.

Three or four loud reports like the bursting of bomb shells were the first intimations of anything unusual. A number of smaller reports followed, resembling the bursting of stones in a limekiln. The stones were seen to fall after the first four loud explosions. Those who happened to be in the woods or near them heard the stones distinctly striking among the trees. In some places the noise of the falling stones in the woods alarmed the cattle and horses in the vicinity so that they fled in terror. A peculiar hissing noise during the fall of the stones was clearly heard for miles around. A very intelligent lady described it as very much like the sound produced by pouring water upon hot stones. The air seemed as if all at once it had become filled with thousands of hissing serpents.

Mr. Crawford and his wife were standing in their yard at the time and hearing a loud hissing sound overhead, on looking up a stone (No. 2) was seen to fall just before them, burying itself 4 inches in the ground. They dug it up immediately but it did not possess any warmth; it had a sulphurous smell. Another, which they did not find, fell near them, when they thought it prudent to retire to the house.

Two sons of John Lamb were in the barnyard attending to their horses when their attention was called to a loud hissing noise above, and immediately a stone (No. 3) fell just at their feet, penetrating the hard tramped earth some 3 or 4 inches, and they state that it was warm when taken from the ground. Another fell in a peach tree near by but the ground being newly plowed they were unable to find it. The largest stone (No. 1) was not obtained until the following day, being dug up beside a horse track on the streets of Buena Vista, Indiana. It had penetrated the hard gravel to the depth of 4 or 5 inches. It had a strong smell of sulphur. The last (No. 4) was dug up by Mrs. Kelly the following day in her yard.

These four aerolites, owing to their being buried deeply in the ground, are all that have been found. None have been found or were heard to fall over a greater area than 4 miles square. Nos. 1, 2, and 3 and a fragment of No. 4 were placed in my hands for examination.

Nos. 1, 2, and 4 were cuboidal in shape, while No. 3 was considerably elongated; they are all covered by a very black vitrified surface, equally intense on every one and on every part of each one, and when broken showed the usual gray color of stony meteorites interspersed with bright metallic particles. The mean specific gravity is 3.465; when broken up and examined under a glass four substances are distinguishable: Metallic particles, dark glassy mineral, dark dull mineral, white mineral matter. Examined as a whole the following elements were found in it: Iron, nickel, cobalt, copper, phosphorus, sulphur, silicon, calicon, aluminum, magnesium, manganese, sodium, potassium, and oxygen. By the action of the magnet it was separated into nickeliferous iron, 4.91, and earthy minerals, 95.09. The earthy minerals, acted on by warm dilute hydrochloric acid thrown on a filter and thoroughly washed, then treated with dilute caustic potash to dissolve any silica of the decomposed portion that was not dissolved by the acid, gave: Soluble portion, 62.49; insoluble portion, 37.51.

The metallic portion separated from the earthy part gave:

Fe	Ni	Co	Cu	P	S	
86.781	13.241	0.342	0.036	0.026	0.022	=100.44

The earthy portion freed from metal gave:

Silica	47.06
Oxyd iron	26.05
Magnesia	27.61
Alumina	2.35
Lime	0.81
Soda	0.42
Potash	0.68
Protoxide of manganese	Trace.

Composition:

Nickeliferous iron	4.989
Schreibersite	.009
Magnetic pyrites	.001
Chrysolite	61.000
Pyroxene and albite	34.000

Only 300 grams of the stones are accounted for in collections, of which Harvard has 85 grams.

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Hartford. See Marion.

Hastings County. See Madoc.

Haviland. See Brenham.

HAYDEN CREEK.

Lemhi County, Idaho.
Latitude 44° 56′ N., longitude 113° 40′ W. (Berwerth); latitude 45° 0′ N., longitude 113° 45′ W. (Ward).
Iron. Medium octahedrite (Om), of Brezina.
Found 1895; described 1900.
Weight, 270 grams (9.5 oz.).

This meteorite was described by Hidden [1] as follows:

The mass of coarsely crystallized iron here described was first brought to my notice by Mr. J. M. Parfet, of Salmon City, Idaho. In a letter dated October 3, 1895, he described its discovery as follows: "The piece of supposed meteoric iron, when first found, was just twice the size of the part I send you. It was kidney-shaped, and in that condition would have been much more valuable (interesting), but the prospector who found it in the bottom of a 12-foot shaft on Hayden Creek, Lemhi County, Idaho, just above the United States agency ground, while prospecting for placer gold, wondered what he had found and went to work on it with a 4-pound hammer. This he kept up at odd times for weeks while in camp, and the first time he came down to the Agency shop, he laid it upon the lap of the anvil and with a 14-pound hammer succeeded in bending it in one way, then turned it over and bent it the other way; this he kept up until he broke it in two. Finding it was not a nugget of gold, he had no further use for it, and I got it from him for a trifle. * * * At the time it was broken, the metal showed at the point of fracture to be almost silver white and was quite pretty, but time has oxidized it considerably, and it has lost its luster."

The above account sets forth the history of the smaller half of this meteorite. Since I recognized it at sight as true meteoric iron, and it was realized that half of it was missing and probably in unappreciative hands, I at once began an inquiry for the missing part. After many months' search, it was traced to the mineral cabinet of Mr. Don McGuire, of Salt Lake City, Utah; and was, after much correspondence, secured by the writer. It is now intact, and has not as yet been analyzed or very critically studied. Its weight is about 9.5 ounces, and it gives evidence of being rich in ferrous chloride (lawrenceite).

The length of the mass, with the two pieces placed together as closely as possible, is 78 mm. Its greatest width is 33 mm. and its greatest thickness 20 mm. It weighs 270 grams as a whole.

No other member of this "fall" has as yet been found, though the miners working in the neighborhood of its discovery have for several years been on the lookout for them in all the gravel workings.

The meteorite is distributed: Chicago, 51 grams; Ward, 42 grams.

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HENDERSONVILLE.

Henderson County, North Carolina.
Latitude 35° 19′ N., longitude 82° 28′ W.
Stone. Spherical chondrite (Cc), of Brezina.
Found 1901; described 1904.
Weight, 6 kgs. (13 lbs.).

This meteorite was first described by Glenn [1] as follows:

In the spring of 1903, Dr. W. H. Jarman, of Nashville, added to the Jarman collection in geology at Vanderbilt University a stony meteorite which had been presented to him by Capt. C. F. Toms, of Hendersonville, North Carolina, who gives the following facts, which contain all the information obtainable as to the time, place, and circumstances of the fall or find.

"About the year 1876, when I was quite a boy, a meteor passed over this town from east to west. My father describes it as being as large as a 'wash pot,' and it appeared to break into three pieces near the spot where this piece came from. It was very bright, lighting up the whole country and exploded with a great roar like a cannon. In 1901, Wm. Corn, a citizen living near the place, about 3 miles northwest of Hendersonville, brought this piece to us, and we recognized what it was. He found it in what is known as the country home for the aged and infirm, probably on the land belonging to it."

The meteorite as received at Vanderbilt University weighed 11 pounds and 6 ounces. The original weight, however, had been perhaps 2 pounds greater than this, as two pieces had been broken off. From one corner a large piece was missing, and from another a small flake had been removed. Concerning these pieces, Capt. Toms says, "The pieces broken off were used to make an assay (which has been lost), and therefore can not be had."

The shape of the mass was somewhat cubical, though one face of the quasi cube was considerably modified by an irregular portion projecting above it. The exact shape of this projecting portion can not now be ascertained, as from it had been taken the larger of the two fragments already referred to. When resting on a face that may very conveniently be regarded as the base, it stands 6⅛ inches high, is 5⅞ inches wide and 5.5 inches thick. Its extreme diagonal length is 8 inches. The edges are all either gently or acutely rounded. A considerable portion of the surface is smooth and nearly flat, while the rest of the surface is covered with irregular, shallow pittings or undulations.

The underlying surface color is almost black, but it is generally obscured by rust-colored areas due to weathering. On broken surfaces it is seen that weathering has produced a rust-colored layer a thirty-second to a sixteenth of an inch thick over most of the surface. While there are no cracks in the mass, yet the interior shows that weathering influences have made themselves felt, to some extent at least, through probably the entire mass. Freshly broken surfaces show a very dark gray mass with many minute rust-colored specks and numerous small masses of metallic luster and either a gray or a light pyritic yellow color.

A piece weighing 1.5 pounds was removed and retained, and the rest of the mass was given in exchange to the United States National Museum, and Prof. G. P. Merrill will doubtless soon publish a description of the mineralogical and other characters of the stone. The fall is new and adds one more to the already considerable list of meteorites known from North Carolina.

Merrill's [2] account was as follows:

All the information available concerning the fall, the finding, and general appearance of the stone here described was given by Prof. L. C. Glenn more than two years ago, with the expectation at that time that the paper here given would shortly follow. Through various causes the matter has been delayed until the present.

According to Professor Glenn, the stone undoubtedly fell in or about 1876, but none of it was found until 1901. The mass, as received by him, weighed 11 pounds and 6 ounces (5.17 kg.), but the original weight was considered as probably some 2 pounds greater, two pieces having been broken off and used in making an assay. The total weight of the original was, then, probably not far from 6 kg. The shape of the mass is shown in a plate, being the stone as received by Professor Glenn. Resting on its base, the stone is very nearly cubical, the dimensions being 15.5 by 15 by 14 cm. It is firm and hard, without cracks, notwithstanding its long exposure, though considerably rusted throughout the interior.

In structure the stone is kugel chondritic and under the microscope presents, so far as observed, no very unusual features. Two pyroxenes, enstatite and a monoclinic form, and olivine make up the silicate portion, with the usual sulphides and metallic portion. The general microstructure of the stone is shown in a plate. The "kugels" of radiating and cryptocrystalline enstatites are of a gray color and sharply differentiated from the groundmass, though usually breaking with it. Chondri of the ordinary porphyritic enstatite and olivine type are common, also of the grate and barred type of the latter mineral. The groundmass consists of an aggregate of olivines, enstatites, and augites, with the customary sprinkling of metallic iron. No true glass was observed. As usual, the monoclinic pyroxene is of much the same general appearance as the enstatite, but readily distinguished therefrom by its inclined though low angle (18°–25°) of extinction. The structure as a whole is much confused, a feature common to stones of this class.

The most interesting feature is the presence of occasional small areas like that shown in a plate. This, under a low power, has all the appearance of a fragment of clastic rock composed of rounded and irregular particles, all of the same mineralogical nature (in this case olivine), embedded in a cement seemingly irresolvable but showing polarizing points. Under as high a power as the thickness of the section warrants using this interstitial material is seen to polarize faintly and to have a granular to fibrous structure. In some instances indistinct finger-like prolongations extend out from the borders of the granules into the interstices. The structure is not at all that of

minerals crystallizing freely from a molten magma, but is suggestive of a partial recrystallization of fine detrital material, as seen in sundry metamorphic schists. The same feature is shown in the fine interstitial portions of another figure of the same plate. It is practically impossible to cut sections thin enough to enable one to write as definitely as desirable, but the structure in both these cases is strongly suggestive of that seen in the meteorite of Kernouve, France, and which F. Rinne, following Tschermak, regards as due to a mechanical trituration and resintering from a subsequent elevation of temperature.

The chemical composition of the stone, as worked out by Mr. Tassin, is as follows:

The portion taken for analysis was badly oxidized. It was therefore kept for sometime at a temperature below red heat in an atmosphere of hydrogen.

The nickel iron was determined in a portion of the mass weighing 2.100 grams. This was pulverized and treated with a solution of mercuric ammonium chloride (12 grams of the double salt, $HgCl_2.2NH_4Cl.2H_2O$, to the liter) in an atmosphere of hydrogen. The native metals thus separated were in the following proportions:

	Found (per cent).	Calculated to 100.
Fe	2.37	91.51
Ni	0.21	8.11
Co	0.01	0.38

The sulphur was determined in a 1.01-gram sample after fusion with sodium carbonate and potassium nitrite. The amount found was 1.61 per cent, which corresponds to 4.43 per cent of troilite. The phosphorus was determined in a 1.5235-gram sample, and 0.012 per cent was found, which corresponds to 0.08 per cent of schreibersite.

The separation of the silicates was effected in a 2.63-gram fragment by treating the finely pulverized mass with dilute hydrochloric acid, specific gravity 1.06, on the water bath for two hours, repeating this operation twice, followed by boiling the moist residue of undecomposed silicate with a solution of sodium carbonate, since the major part of the silica of the soluble silicate will be here found.

The analysis of the soluble silicate gave:

	Found (per cent).	Calculated to 100.
SiO_2	15.66	38.34
FeO	9.44	23.10
Al_2O_3	0.20	0.49
Cr_2O_3	0.03	0.07
CaO	0.15	0.36
MgO	15.38	37.46
	31.86	100.00

The insoluble silicates, analysis below, were decomposed by fusion with sodium carbonate. The alkalies were determined in a separate portion.

	Found (per cent).	Calculated to 100.
SiO_2	30.40	56.01
FeO	4.89	9.01
Al_2O_3	2.00	3.68
Cr_2O_3	0.20	0.37
CaO	1.98	3.65
MgO	13.24	24.39
K_2O	0.10	0.18
Na_2O	0.96	1.77
Chromite	0.51	0.94
	54.28	100.00

The general composition of the meteorite may be arrived at by combining the results of the several determinations thus:

Fe	2.37
Ni	0.21
Co	0.01
S	1.61
P	0.012
SiO_2	46.06
FeO	14.33
Al_2O_3	2.20
Cr_2O_3	0.23
CaO	2.13
MgO	28.62
K_2O	0.10
Na_2O	0.96
Residue (chromite)	0.51
	99.352

From these several analyses it is possible to arrive at the following approximation of the relative quantities of the different constituents:

Nickel iron	2.59
Troilite	4.43
Schreibersite	.08
Chromite	.80
Olivine	40.48
Pyroxenes	51.62
	100.00

In the above the amount of the nickel iron is given as directly determined. The sulphide and phosphide of iron are calculated from the amount of sulphur and phosphorus found; the chromite is similarly calculated. The soluble silicate is regarded as olivine; the insoluble silicate as being largely enstatite, with some augite.

The meteorite is chiefly preserved in the U. S National Museum.

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Henry County, 1889. See Hopper.

Henry County, 1857. See Locust Grove.

HEREDIA.

San José, Costa Rica, Central America.
Latitude 10° 2′ N., longitude 84° W.
Stone. Brecciated spherical chondrite (Ccb) of Brezina; Canellite (type 48) of Meunier.
Fell at night, April 1, 1857; described 1859.
Weight: Several stones of which one weighed 1 kg. Assignable weight, 707 grams (1.5 lbs.).

The original description of this meteorite, presumably by Domeyko,[2] the present writer has been unable to consult. The following account was given by Buchner:[3]

Several stones of considerable size resulted from this fall, which was preceded by a swiftly moving fireball and a loud detonation.

The stone is covered with a thin black crust, which is not distinguishable from the inner substance which is gray and appears to contain much graphite in flat, thin flakes. It is very compact and contains shining globules of metallic iron.

Analysis (Domeyko):

A. The magnetic portion (26.1 per cent):

Fe	Ni	
94.2	5.7	=99.

B. Nonmagnetic portion (73.9 per cent):

	SiO_2	Al_2O_3	FeO	NaO	KO	CaO	MgO	
Soluble	33.6	.....	30.9	.....	.....	0.1	35.1 (with some Ni and MnO)=	99.7
Insoluble	56.7	3.5	14.5	2.3	0.1	3.2	19.6 (with 0.13 chromite)	=100.03

Mineralogical composition:

Nickel iron	26.1
Olivine	38.1
Oligoclase	6.4
Augite	29.4

To which add magnetic pyrites and a phosphide, with chromite, not over 0.002 of the whole.

Brezina [5] remarks that the Tübingen piece resembles Cgb and is very rusty.

The meteorite is distributed, Göttingen having the largest piece (422 grams).

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Highland County. See Pricetown.

HOLLANDS STORE.

Chattooga County, Georgia.
Here also Chatooga County.
Latitude 34° 22′ N., longitude 85° 26′ W.
Iron. Brecciated hexahedrite (Hb) of Brezina; Caillite (type 18) of Meunier.
Found 1887; described 1887.
Weight, 12.5 kgs. (27 lbs.).

This meteorite was described by Kunz [1] as follows:

This mass of meteoric iron was found by Mr. W. J. Fox, about March 27, 1887, on his farm in Hollands Store, Chattooga County, Georgia. In all 27 pounds (12.5 kg.) were found, but the mass fell into the hands of parties from Alabama who were interested in developing iron mines, and was broken in pieces, three of which, weighing 9, 1.5, and 0.5 pounds respectively, came into my possession, while the balance were worked into nails, horseshoes, and other forms by the local blacksmiths. It is one of the "Hexaëdrische Eisen" of Brezina, with twinning laminæ No. 60, and one of the Caillite group of Meunier. The specific gravity as obtained by me is 7.615.

The smaller of the Whitfield County masses was found 20 miles northeast, and the larger mass 14 miles northeast, of Dalton, while this was found 30 miles southwest of Dalton. The fracture is in part granular, resembling in this respect the Seeläsgen iron. But the cleavage is in some parts very marked, and the two cleavage angles measured were 120°. In breaking up the iron four cleavage planes were obtained, one of the surfaces being 2 cm. square and two others 3 cm. square each, which were very smooth and bright. On etching with weak nitric acid the iron turned dark and markings became visible that had all the appearance of scratches due to imperfect polishing. In fact they were at first mistaken for scratches, and the iron was twice repolished. In this respect, and in its hardness it very closely resembles the Butcher irons. They are the Neumann figures, a result of a twinning of the cube described by Tschermak. The iron was then treated with strong nitric acid and evenly dissolved away, with the exception of the eating out of one of the layers parallel with the cleavage face and undoubtedly the same with it. It has included round masses of troilite distributed quite plentifully through it, from 3 to 8 mm. in diameter, and on polishing down the side of the iron these were found so much altered as to be scarcely distinguished as such, rather resembling compact limonite. Lawrencite, chloride of iron, is very plentiful in this iron and collected in large drops on the surface and rolled off into the tray containing the specimen.

The following analyses were kindly furnished by Mr. J. Edward Whitfield, of the U. S. Geological Survey:

	1	2	3
Fe	94.67	94.66	94.60
Ni	.....	.....	4.97
Co	.....	.....	.21
P	.....	.....	.207
			99.987

The specific gravity of the largest piece received is 7.801.

There is a very slight trace of S and C but hardly enough to determine.

This iron does not bear the slightest resemblance to either of the Whitfield County, Georgia, irons, and is a white iron, whereas the Walker County, Alabama, iron has a bluish cast and was found over 100 miles due east.

Huntington [2] included Hollands Store with Sancha Estate, Fort Duncan, and Scottsville as one fall.

Fletcher [3] remarked that the character of fracture upon which Huntington based this view is insufficient for such a conclusion.

Meunier [4] described the iron as very compact, and stated that the presence of nickel is doubtful, and that it shows no figures on etching.

Brezina [5] classed the iron as a brecciated hexahedrite and described it as follows:

The surface is smoothed off by weathering, yet the interior is still fresh. The grains vary in size from extreme fineness to 10 cm. in diameter. The individual grains under the glass, besides unitary Neumann lines running through them, frequently show a fine granular composition. The double structure recurs also on a large scale, since blades of rhabdite arranged in planes run undistorted through all the grains. On account of the interior binding together of jagged, interlocking grains, the whole iron makes the impression of an immense kamacite lamella. In one part of the iron occur grains of magnetite of the size of mustard seeds or hazelnuts.

Cohen [6] described the structure and gave an analysis as follows:

The structure varies so that on one end of the mass there is a fine-grained aggregate; then come large, isolated grains, and finally unitary hexahedrites inlaid with small isolated grains. The smaller grains are as a rule rounded, irregular, and of varied form; every part shows the same oriented luster. The Neumann lines and pittings are very distinct. Under the microscope, many grains show a fine network of hair-like cracks, which must be regarded as a sort of fracture phenomenon, since the luster remains peculiar. In others are found tiny dark inclusions; it is this, doubtless, which constitutes the granular character mentioned by Brezina. Besides fine rhabdites there are also a few large schreibersites surrounded with a small smooth etched zone.

Analysis (Zaubitzer):

Fe	Ni	Co	Cu	Cr	S	P	C	Residue	
93.06	5.35	1.00	....	0.23	0.08	0.31	....	0.08	=100.11

The meteorite is distributed, the Vienna collection possessing the largest quantity, 2,157 grams.

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3. 1890: Fletcher. Mexican meteorites. Mineral Mag., vol. 9, p. 106.
4. 1893: Meunier. Révision des fers météoriques, p. 76.
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HOMESTEAD.

Iowa County, Iowa.
Here also Amana, Iowa County, Marengo, Sherlock, and West Liberty.
Latitude 41° 45′ N., longitude 91° 53′ W.
Stone. Brecciated gray chondrite (Cgb), of Brezina; Limerickite (type 38, subtype 2), of Meunier.
Fell 10.15 p. m., February 12, 1875; described 1875.
Weight, 210 kgs. (460 lbs.).

The first scientific mention of this great meteoric fall seems to have been in the American Journal of Science for May, 1875,[1] where it is stated that a meteor fell in Iowa on the night of February 12, with loud detonations. The principal portion of the fragments from the stone are stated to have been secured for the Iowa State University by Professor Leonard. A preliminary examination of the gases of the meteorite by Professor Wright [2] was reported in the next (June) issue of the Journal as follows:

By the courtesy of President Thacher, of the State University of Iowa, the writer has received some fragments of this meteorite, an examination of which has yielded some very interesting results. The meteorite is of the stony kind, containing numerous small grains of metallic iron, and not greatly differing in appearance from others of its class.

A quantity of the iron, having been separated, was found to contain several times its volume of gaseous substances, much of which it yielded on a very moderate elevation of temperature. The spectroscope plainly indicated the predominance of carbon compounds, and an analysis showed that very nearly one-half of the gas was made up of the two oxides of that element, the approximate percentages being CO_2, 35; CO, 14; the two together, 49 per cent. The residue consisted largely of hydrogen, but the exact proportion was not determined. These relations show a marked difference between the iron and the stony meteorites as to their gaseous contents, as in the former the hydrogen is most abundant, while in the latter the oxides of carbon are the characteristic constituents.

The spectrum of the gases at a few millimeters pressure gave the carbon bands very brilliantly, the hydrogen lines being comparatively weak and inconspicuous, though at a very low pressure they become relatively stronger. The brightest carbon bands were the three in the green and blue, the red one being much feebler. Now these are precisely the ones most conspicuous in the spectra of some of the comets, and this fact is a remarkable confirmation of the received theory as to the meteoric character of these bodies.

In the next (July, 1895) number of the Journal a further account of the examination was given by Wright,[3] as follows:

This meteorite fell, on the date above mentioned, in Iowa County, in the State of Iowa. By the agency of Prof. N. R. Leonard, of the Iowa State University, a large amount of the meteoric mass was collected, and from him, by the courtesy of President Thacher of the same institution, a number of fragments were received by the writer for an examination, of which a brief notice was published in the preceding number of this journal. A description of the meteorite, and of the circumstances which attended its fall, by Professor Leonard, will be given in the next number of the journal.

The meteorite is of the stony kind, not greatly differing in its general appearance from others of the same class. Numerous small grains of metallic iron and of the magnetic sulphide of iron, or troilite, are scattered through the mass, the iron grains ranging in size from the finest particles, like mere powder, to those of the size of a fig seed, with occasionally one as large as a grape seed.

Among the fragments received there are some which show distinct evidences of a sort of lamination or imperfect stratification, the portions at which the surfaces separated being smoothed down, as if by pressure or friction. Several minute veins are visible, which appear to be filled with material of somewhat different constitution. Their relation to the general mass can not be distinctly made out, and it is doubtful whether they indicate anything more than that cracks formed in the mass while cooling, and that the fissures thus formed were filled up again, perhaps by the still fluid matter from the interior. They seem to indicate that the mass of which the meteorite probably once formed a part was of great size.

The recent investigations of Professors Newton, Schiaparelli, Oppolzer, and others, in respect to some of the great meteoric streams, have resulted, on the one hand, in establishing the identity of their orbits with those of certain well-known comets, and on the other, in showing that the bodies belonging to these streams are probably of the same nature as the sporadic or occasional meteorites. It seemed probable, therefore, that an examination of the gases yielded by a freshly fallen meteorite would be likely to furnish important information respecting the tails of comets, and these anticipations were found to be not unwarranted by the results.

The examination was made in the manner described in a previous article, and with the same apparatus. The first trial, which was made with a quantity of iron extracted from the meteoric mass, showed that the gaseous contents differed in a marked degree from those obtained from iron meteorites hitherto examined, inasmuch as they contained a very large percentage of carbon dioxide, with a smaller proportion of carbonic oxide, and a large residue of hydrogen, the two oxides of carbon making about one-half of the gaseous mixture. The percentages obtained in the preliminary trial were: CO_2, 35; CO, 14; or 49 per cent of carbon compounds, the hydrogen not having been estimated. This was merely a rude approximation, and the amount of CO is overestimated, at the expense of the CO_2. These results were obtained with the particles of iron separated from the powdered stone with a magnet. The residue, however, contained a considerable amount of iron particles too small to enable them to lift the bits of the stony matrix in which they were inclosed. As this was found to introduce irregularities in the determinations, the portions of meteorite employed in the experiments to be described were finely pulverized in a diamond mortar, and the whole immediately placed in the glass tube to be attached to the Sprengel pump, the iron not being separated from the rest. Larger volumes of the gases were extracted than in the first trial, and the relative proportions of the different constituents carefully determined by analysis.

Powder formed from about 4 cc. of the solid meteorite was placed in the tube upon the pump, and the air very thoroughly exhausted. It was soon found that the relative amounts of the different constituents driven off by heating the tube varied with the temperature, and the experiments were so conducted that the portions separated at different temperatures could be examined separately.

On applying the heat of the hand to the tube for a short time, a small amount of gas was liberated, too small for anything more than a rude qualitative test as to its composition, which showed the presence of carbon dioxide and some hydrogen. The tube and its contents were then brought to the temperature of boiling water by surrounding it with a wider glass tube, through which steam was passed for several hours. Gas was given off in considerable quantity, and enough was collected for an analysis. This was found to contain 95.46 per cent of carbon dioxide and 4.54 per cent of hydrogen, the carbonic oxide, if present, being in too small amount for estimation with certainty. A moderate heat was now applied for a short time with a small Bunsen flame, raising the temperature to 200° or 250°. This separated a still greater quantity of the gases, in the following proportions: CO_2, 92.32; CO, 1.82; H, 5.86. A stronger heat was then applied for nearly an hour, the temperature, however, being kept below that of redness. About 3 cc. of gas were given off, which was found to consist of CO_2, 42.27; CO, 5.11; H, 48.06; N, 4.56. The tube with its contents was now brought to a low red heat, which was maintained for half an hour or so, the effect being to liberate nearly the same volume of gas as before, containing CO_2, 35.82; CO, 0.49; H, 58.51; N, 5.18. Finally, it was brought to a full red heat, which caused the evolution of much more gas, yielding, on analysis: CO_2, 5.56; CO, 0.00; H, 87.53; N, 6.91. The whole amount of gas given off was about two and one-half times the volume of the solid portion of the meteorite employed, but this was not the whole, for the heat was discontinued before its evolution had entirely ceased. If referred to the iron alone, it would be about twenty times its volume.

The following table gives the relative proportions of the gases obtained at different temperatures, the nitrogen being determined as a residue:

	At 100°	At 250°	Below red heat	At low red heat	At full red heat
CO_2....	95.46	92.32	42.27	35.82	5.56
CO....	0.00?	1.82	5.11	0.49	0.00
H.....	4.54	5.86	48.06	58.51	87.53
N.....	0.00	0.00	4.56	5.18	6.91
	100 00	100.00	100.00	100.00	100.00

No hydrocarbon compounds of the olefiant series, capable of absorption by fuming sulphuric acid, were found, nor any marsh gas, sulphurous oxide, hydrogen sulphide, or chlorine. A small amount of water vapor was driven off by the heat, but not more than the ordinary quantum of hygroscopic moisture which such a substance would absorb from the air.

It will thus be readily seen that the iron and the stony meteorites show a marked distinction as to the gases which they contain. For, while hydrogen is the principal gas of the irons, in the Lenarto specimen amounting to 85.68 per cent; in those of the stony kind, if this one may be taken as representative of the class, the characteristic gas is carbon dioxide, and this, with a small proportion of carbonic oxide, makes up more than nine-tenths of the gas given off at the temperature of boiling water, and about half of that evolved at a low red heat.

The spectrum of the gases consisted of the hydrogen and carbon spectra together, resembling in a general way that of the gases from iron meteorites, but differing from them in the greater relative intensity of the parts due to carbon compounds. At a few millimeters' pressure, indeed, the hydrogen spectrum was almost overpowered by them. The three middle carbon bands, those in the yellow and green were very bright, that in the green being most intense of all. In the broad part of the tube these constituted nearly the whole of the spectrum visible, the green hydrogen line being scarcely discernible, and the others not at all. These are precisely the three bands observed in the spectrum of some of the comets, and they have the same relative order of intensity. * * *

Irish[4] made a thorough and careful study of the course of the meteor and the phenomena of its fall. A part of his account follows:

From the first the light of the meteor could hardly be tolerated by the naked eye turned full upon it. Several observers who were facing south at the first flash say that upon looking full at the meteor it appeared to them round, and almost motionless in the air, and as bright as the sun. Its light was not steady, but sparkled and quivered like the exaggerated twinklings of a large fixed star, with now and then a vivid flash. To these observers, all of whom stood near the meteor's line of flight, its size seemed gradually to increase, also its motion, until it reached a point almost overhead, or in a direction to the east or west of the zenith, when it seemed to start suddenly and dart away on its course with lightninglike rapidity.

The observers who stood near to the line of the meteor's flight were quite overcome with fear, as it seemed to come down upon them with a rapid increase of size and brilliancy, many of them wishing for a place of safety, but not having time to seek one. In this fright animals took part, horses shying, rearing, and plunging to get away, and dogs retreating and barking with signs of fear. The meteor gave out marked flashes in its course, one more noticeable than the rest, when it had completed about two-thirds of its visible flight. All observers who stood within 12 miles of the meteor's path say that from the time they first saw it, to its end, the meteor threw down "coals" and "sparks."

Thin clouds of smoke or vapor followed in the track of the meteor and seemed to overtake it at times and then were lost. These clouds or masses of smoke gave evidence of a rush of air with great velocity into the space behind the meteoric mass. The vapor would seem to burst out from the body of the meteor like puffs of steam from the funnel of a locomotive or smoke from a cannon's mouth, and then as suddenly be drawn into the space behind it. The light of the meteor's train was principally white, edged with yellowish green throughout the greater part of its length, but near to the body of the meteor the light had a strong red tinge. The length of the train was variously estimated but was probably about 9°, or from 7 to 12 miles, as seen from Iowa City. The light about the head of the meteor at the forward part of it was a bright, deep red, with flashes of green, yellow, and other prismatic colors. The deep red blended with and shaded off into the colors of the train at the part following; but the whole head was inclosed in a pear-shaped mass of vivid white light next to the body of the meteor, and the red light fringed the white light on the edges of the figure and blended with it on the side presented to the eye.

From three to five minutes after the meteor had flashed out of sight, observers near the south end of its path heard an intensely loud and crashing explosion, that seemed to come from the point in the sky where they first saw it.

This deafening explosion was mingled with, and followed by, a rushing, rumbling, and crashing sound that seemed to follow up the meteor's path, and at intervals, as it rolled away northward, was varied by the sounds of distinct explosions, the volume of which was much greater than the general roar and rattle of the continuous sounds. This commotion of sounds grew fainter as it continued, until it died away in three to five explosions much fainter than the rest.

From one and a half to two minutes after the dazzling, terrifying, and swiftly moving mass of light had extinguished itself in five sharp flashes, five quickly recurring reports were heard. The volume of sound was so great that the reverberations seemed to shake the earth to its foundations, buildings quaked and rattled, and the furniture that they

contained jarred about as if shaken by an earthquake; in fact, many believed that an earthquake was in progress. Quickly succeeding, and in fact blended with the explosions, came hollow bellowings and rattling sounds, mingled with a clang and clash and roar that rolled slowly southward as if a tornado of fearful power was retreating upon the meteor's path.

In September, 1875, an account was published by Hinrichs [5] as follows:

On the evening of Friday, February 12, 1875, at 20 minutes past 10 o'clock, one of the most brilliant meteors of modern times illumined the entire State of Iowa and adjacent parts of the States of Missouri, Illinois, Wisconsin, and Minnesota. The southeastern portion of Iowa was bright as day, while the great meteor, in descending to the earth, passed from Appanoose County to Iowa County. The meteor, in rapidly moving through the atmosphere, produced a great variety of sounds—rolling, rumbling, and detonations of fearful intensity—which, in a large part of Iowa County, shook the houses as if moved by an earthquake.

But three days after the great phenomenon a meteoric stone weighing 7 pounds was found by Miss Sarah Sherlock while on her way from school, precisely where observers had seen a "glowing coal" descend to the earth. In April and May, while the farmers were cultivating the land, about 400 pounds of meteoric stones were gathered on the meteorite field of Iowa County. Quite recently two large meteorites have been found, aggregating 120 pounds. But these 500 pounds of meteoric stones are apparently only a portion of a smaller fragment of the entire meteoric body, so that the whole mass falling to the earth, as the great Iowa meteor of February 12, 1875, must have weighed about 5,000 pounds. Even what has been gathered thus far permits us to rank this meteor among the best observed and richest in meteorites on record.

* * * * * * * * *

The great Iowa meteor consisted of an elongated, pear-shaped mass of the most dazzling whiteness. The bulk of this mass was about 2,000 feet long and 400 feet in diameter; the narrow white trail was about 4,000 feet long and 40 feet in diameter. This body was posteriorly enveloped by a much less brilliant trail, shading from orange inside to greenish outside, and extending about 9 miles along the described path of the meteor. Persons in the track of the meteor saw a brilliant circular disk of white light surrounded by an orange to greenish halo, the dim light of which was constantly traversed by narrow bands of brilliant white, running from the central disk in irregularly curved lines toward the circumference. As this body, increasing in brilliancy and apparent magnitude, was rapidly approaching, both men and animals were overcome with fear.

The meteor, when by striking the atmosphere of the earth it became visible, was at an altitude of 150 miles vertically above the little village of Pleasantville, about midway between Kirksville and Milan, in northern Missouri. Descending at an angle of about 45 degrees toward the earth's surface, it moved a little east of north, gradually deviating more and more toward the east so as to describe a curve, the concavity of which was turned eastward. This track of the meteor passed a couple of miles east of Centerville and Moravia in Appanoose County, Iowa; almost directly over Eddyville on the Des Moines River; crossed almost diagonally the northeastern (Prairie) township of Keokuk County; passed 1.5 miles east of Marengo in Iowa County; and finally exploded over a point 3 miles southwest of the little station of Norway on the Chicago & Northwestern Railroad, over the boundary line of Benton and Iowa Counties, at an altitude of about 10 miles. The total length of the orbit is 210 miles, through which the meteor passed in about 10 seconds, or at the rate of 21 miles per second.

As the meteor crossed Prairie Township it was seen to divide into two unequal parts, a small eastern portion continuing its motion northeastward, but soon losing its brilliancy, and a seven to fourteen times greater western portion which remained intensely brilliant until its final explosion. It was the smaller portion of the meteor which produced the shower of meteorites in Iowa and Amana Townships of Iowa County; hence it is highly probable that several thousand pounds of meteorites, some in pieces of over a hundred pounds, will yet be found east and north of the final explosion of the main portion of the meteor; that is, in Florence Township of Benton County, in Fairfax Township of Linn County, and in Lenox Township of Iowa County. In fact observers saw "large glowing coals," as they described them, fall in this region where Linn, Benton, and Iowa Counties meet.

While dividing the meteor produced two tremendous detonations, and after the main body had crossed the railroad at Marengo it produced three terrific detonations, which shook the buildings for miles around so as to produce the impression of an earthquake.

Besides these detonations the meteor was accompanied with a variety of other sounds, heard over a circular area of 150 miles in diameter. To those farthest away from the orbit it sounded as if their chimneys were on fire, and astonishingly large number of persons missed the sight of the meteor because they hurried to their stoves and flues to check the apparent fire. Those nearer the track heard a prolonged rumbling and rolling sound like that produced by a train passing over a long, high trestle-bridge. Others still nearer the final explosion hurried upstairs, thinking the plastering had fallen on the heads of their children sleeping in the upper story. Many in this same region heard the clank and clatter of heavy, hard bodies striking against each other or against the hard ground.

The meteorites thus far found occur in an elliptical area stretching from Amana von der Höhe, in Amana township, to Boltonville, in Iowa township, a distance of 8 miles. The minor axis of this ellipse measures about 3 miles. The entire meteorite field of Iowa County thus far covers, therefore, an area of 18 square miles. In the northwest the largest pieces are found; toward the southeast the meteorites become gradually smaller. This agrees with their derivation from the minor portion of the meteor. As the entire drift was eastward, the resistance of the air would, to some extent, produce precisely this distribution of the meteorites, according to size.

The principal village near the meteorite region is Homestead, a station on the Chicago, Rock Island & Pacific Railroad about 20 miles west of Iowa City. This little station became the headquarters of the "meteor-brokers"; for $2 a pound had been offered for all these stones. Enormous profits were made, creating a "meteor excitement" in the region.

Mineralogy pertaining to my chair of physical science in the Iowa State University, I felt it my duty to furnish the mineralogical cabinets with good specimens of the meteorites which fell in my neighborhood. I have, through the personal and financial assistance of the Hon. John P. Irish, of Iowa City, brought together three collections, the first two of which have been photographed. A subjoined cut is a copy of the photograph of the first collection. It shows the general form of each of the specimens, numbered in the order of their weight. The photographs themselves, in one-fifth natural size, are very excellent, permitting even a close study of the granulations and surface. The cut mentioned gives the specimens in one-seventh of their natural size.

The following catalogue gives the specimens of my collections in the order of their weight. The numbers correspond with those on a map of Iowa township. No. 0 on the map indicates the "Sherlock stone," the one first found:

Collection.			Weight.		Weight	Presented to the mineralogical
I	II	III	Lbs.	oz.	in grams.	museum of—
.	..	21	21	00	9,500	
.	..	20	12	4	5,761	
1	..	..	10	4	4,650	Paris.
2	..	..	8	5	3,793	London.
3	..	..	8	0	3,620	
.	10	..	7	13	3,562	
.	11	..	7	3	3,268	St. Petersburg.
.	12	..	6	10	3,013	
4	..	..	6	5	2,856	Vienna.
.	13	..	5	14	2,663	Brussels
5	..	..	5	3	2,634	Copenhagen
.	14	..	5	7	2,464	Haarlem
6	..	..	5	0	2,274	Berlin
.	15	..	4	11	2,142	Paris
7	..	..	4	8	2,040	Christiania
8	..	..	4	0	1,819	Stockholm
.	16	..	3	6	1,545	Munich
9	..	..	2	3	997	Lausanne
.	17	..	1	7	669	
.	18	..	1	4	567	
.	19	..	1	4	560	West Point, New York
Total.....			133	00	60,500	

But a few days ago (on June 30) I received a dispatch from the meteorite headquarters that quite a large specimen had been found. Since, an additional, somewhat smaller stone has been found on the same section of land, namely, on section 30 of the township directly north of Iowa township, or about 2 miles north of the spot *A* in section 6 of the map, but a little south of the society village called Amana von der Höhe. I have visited this place and been kindly permitted to examine these truly beautiful specimens. The larger meteorite forms an irregular, rounded rhomb, 15 inches diagonal and 8 inches thick; it weighs 75 pounds, or 33.6 kg., and is completely covered with a black crust—i. e., a complete stone. The smaller meteorite forms an irregular rhomboid, the diagonals of which are 16 and 10 inches, while it is 12 inches thick; it weighs 48.5 pounds, or 21.1 kg. One of its sides has but a secondary crust, so that another piece of perhaps 20 pounds must be found in the neighborhood. The smallest complete stone is in the possession of Mr. William Moerschel; it is a lenticular stone, weighing 2 ounces only. The largest stone found weighs, therefore, 624 times as much as the smaller.

The two admirable specimens just described belong to the largest meteoric *stones* on record. The Amana Society has confided these two remarkable specimens to me for study. They appear to have formed but one stone when the meteor first struck our atmosphere.

The number of meteorites thus far found in Iowa County is about 100; the total weight is over 500 pounds, or 225 kg. The Iowa County meteorites are all alike, bounded by irregular plane surfaces, indicating the usual fragmentary nature of meteorites. They are all covered with a black crust, formed during the cosmical part of their motion through the earth's atmosphere. This crust is not due to fusion, but simply to the heating of the outer layer of the stone to a red heat, as has been proved by Meunier. Indeed, the gray mass of these meteorites turns very readily black by exposure to a red heat. The surface of these meteorites shows all the ordinary impressions of meteoric stones; the finger marks, granulations, ripples simulating the flow of fused matter, etc. The anterior side is, as commonly, deeper black than the posterior side; the latter has the smaller finger marks.

These meteorites are exceedingly tough, so that it is difficult to break them up; this is due to the iron grains being partly connected by fibers and folia. Still, the nickeliferous iron is present in detached masses or occurs sporadically in the stone. Hence these meteorites belong to the great class of "Sporadosidères" of Daubrée. In this class Daubrée

distinguishes three species—those containing much, little, or but very little iron, so that it can only be recognized by a magnifier or a microscope; these species he designates as "Poly-," "Oligo-," and "Krypto-Sporadosidères." Accordingly the Iowa County meteorites are "Oligo-Sporadosidères."

The following table gives the result of my analyses of the average composition of the Iowa County meteorites:

Nonmetallic—	Iron.	Nickel.	Sulphur.	Ferrous oxide.	Magnesia.	Lime.	Silica.	
Troilite	1.1	...	0.7	(1.5)	....	...	....	= 1.8
Hyalosiderite	...	...	...	15.2	17.5	0.6	19.6	= 52.9
Hypersthene	...	...	...	8.8	9.7	2.2	24.2	= 44.9
Loss, traces	...	...	...	....	....	...	....	= .4
Sum	1.1	...	.7	24.0	27.2	2.8	43.8	=100.0
Magnetic—								
Nickeliferous iron	6.6	0.9	...	....	....	...	....	= 7.5
Total	7.7	.9	.7	24.0	27.2	2.8	43.8	=107.5

The Iowa County meteorites are "Oligo-Sporadosidères;" that is, meteoric stones containing but little plainly visible metallic iron in detached grains. They contain 7 per cent by weight of metallic iron. Specific gravity, 3.57.

The fracture is very rough and uneven, showing the lustrous metallic iron and lighter gray chondri (the chondrites of G. Rose). The grains of lighter color contain less of iron silicate, but are otherwise composed of the same minerals, namely, olivine (soluble in HCl) and pyroxenes (insoluble in HCl) besides some troilite.

Nonmagnetic	Troilite	1.8	Soluble =54.7
	Olivine	52.9	
	Pyroxene	44.9	Insoluble =44.9
Magnetic	Nickeliferous iron	7.5	

A trace of manganese remains with the ferrous oxide; also a small amount of alumina. The trace of sodium is sufficient to give a brilliant line in the spectroscope; the lithium line, while quite distinct, is not brilliant.

A detailed account of the meteor was given in November of the same year by Leonard,[1] as follows:

On the evening of February 12, 1875, at about half past 10 o'clock, a very large meteor was seen passing from southwest to northeast over northern Missouri and southern Iowa, and coming to the earth in a shower of stones a few miles east of Marengo, Iowa County, Iowa. At this hour the sky seems to have been quite clear over the greater part of the States named, though light clouds and a sort of haze are spoken of by observers in the counties adjoining the place where the stones fell, so that the meteor was seen throughout a region extending at least 400 miles in length from southwest to northeast and 250 miles in breadth. In their descriptions of the course it pursued the accounts of observers varied with their positions relative to the place where it fell. Those east of this region thought the course to be toward the west or northwest, those north described it as moving toward the south or the southeast, and in a few cases the statements of the different observers in the same town are contradictory as to the direction of its motion.

The brilliancy of its light and the concussion which accompanied its fall were such as to attract very general notice considering the lateness of the hour, and the observations herewith presented will be found to determine the path it pursued with a fair degree of accuracy. At Keokuk, Iowa, it is described as: "Oblong in figure, with a train ten to twelve times the length of the body, giving an intensely brilliant light, of crystalline whiteness at the center, fire-red on the border, and throwing out red sparks and purplish jets of flame; train less luminous than the body; exploded like a rocket. Opinions were divided as to whether any detonation accompanied the explosion." These observations were collected by L. C. Ingersoll, M. D., from a number of persons in Keokuk who witnessed the flight.

At Washington, Iowa, Rev. E. B. Taggart, in a letter to the Free Press of that city, describes it as of a "horseshoe shape, greatly elongated. The outer edge very bright, then a narrow dark space, with a core of intense brilliancy, so vivid as to blind the eyes for a moment. It had not a comet-like train, but a sort of following jacket of flame. Detonations heard so violent as to shake the earth, and to jar the windows like the shock of an earthquake."

At Iowa Agricultural College, Professor Macomber says: "In form it was like an immense rocket with streamers flowing from the hinder part, the front being smooth and curved like a saber. Its color was at first brilliant white, illuminating the sky like a flash of lightning, then fading gradually into yellow, then a deep rich orange, almost scarlet, when it burst."

At Sigourney, almost directly under the path of the meteor, Mr. J. A. Donnell, writing to the Sigourney News, speaks of it as "a globe of fire with pale lines of light radiating from it. The light of the globe very vivid. It appeared to be falling toward the earth from about 10° west of the zenith." He says he could see it dropping through a succession of clouds until it came inside the dome above him, where it apparently stood still for a moment and then passed over toward the northeast. The detonation was compared to the discharge of a 40-gun battery which he had heard in the army.

At Amana, about 5 miles northeast of the middle region where the meteor fell, Mr. F. Christen says that "Its light was at first dazzling white, then changed to red. Threw distinct shadows of objects on the street. Fragments seemed to separate, not with violence, but simply as if falling apart; the separation was speedily followed by the disappearance of the meteor."

Mr. G. Holm, of Marengo, gives an account similar to the last, and in addition, says that the descending path was wave-like and a not a uniform curve. Mr. Frank McClintock, of West Union, says that "at about the middle of its course it appeared to give a slight dart or bound toward the east." Probably the same wave-like motion spoken of by Mr. Holm, when viewed from a station not far removed from the direction in which the meteor was moving.

At Mount Pleasant, Iowa, Professor Mansfield states that some of the observers thought that the meteor attained its maximum brightness when about due west of that place. Some of the students who were familiar with the color of the flames of different substances with which they had experimented in the chemical laboratory called out at the time that the color of the meteor showed iron and copper.

In computing the path pursued by the meteor, I have relied almost entirely upon observations which could be verified afterwards by reason of its having passed near to or behind some recognized point on a building or object whose altitude and bearing from the station of the observer have been ascertained by instrumental measurement, as follows (the location of the observer is indicated by the section, township, and range numbers):

1. At Amana (northwest corner of 26–81–9). Mr. F. Christen first saw the meteor when at an altitude of 10 or 11 degrees and at a bearing of S. 19° W. Soon after he saw it passing near the top of a chimney, whose bearing and altitude were, respectively, S. 26° W. and 17.5°, and finally saw it separate and disappear at an altitude of 29° bearing S. 65° W.

2. At Mount Pleasant (4–71–6) there is not a perfect agreement as to the altitude of the meteor when due west of that place. Some thought that it passed very near the moon, others thought that it passed above it, and one at least gives its altitude as less than that of the moon. One observer spoke of seeing it when at a bearing of about S. 14° W.

3. At Albia, Monroe County (15–72–17), Mr. Pascal T. Lambert saw it when due east at an altitude of 40 to 45 degrees, and pointed out the place of its disappearance, which was found to have a bearing of N. 41° 30′ E., or almost exactly in the direction of South Amana, in which vicinity it fell.

4. Mr. E. H. Warrall, of the United States Corps of Engineers, at Keokuk, Iowa (24–65–5), gave its altitude, when at a bearing of about N. 60° W., at between 10 and 12 degrees. Another gave the altitude near the same place at 10° 30′. Both observers saw the meteor disappear behind a church steeple.

5. Rev. E. B. Taggart, of Washington, Iowa (17–75–7), thought it passed 10 or 15 degrees west of the moon.

6. Prof. J. K. Macomber, of the Iowa State Agricultural College (4–83–24), first saw the meteor when at an altitude of 7 or 7.5 degrees and bearing S. 55° E. This observation is almost exactly accordant with one taken independently at the same place by a student who was engaged at the time in taking meteorological observations.

7. Mr. J. A. Donnell, of Sigourney (2–75–12), thought that the meteor passed about 110° west of the zenith of his place; no means of verifying his observations, and no measures taken.

8. Mr. Ream, telegraph operator at Oskaloosa (13–75–17), gave the zenith distance of the meteor when due east as about 35°. No measures taken.

9. C. D. Leggett, Esq., of Fairfield (25–72–10), estimated its zenith distance when northwest of him at 25°. * * *

(From these observations the course of the meteor can be approximately indicated by a line drawn through Agency City and South Amana, Iowa, at a bearing of about N. 18° E.) * * *

The product of this meteoric fall was a large number of irregularly shaped stones, varying in weight from a few ounces up to 74 pounds, and aggregating, so far as found, 500 pounds. The largest specimens were found at the northern part of the area covered, those at the southern end being all small. A part of this area is timbered and low lying, so that larger pieces hidden by forest or water may yet be found.

These meteoric stones are many of them entirely covered with ordinary black coating, and they all present the "pitted" appearance common to such bodies. In several instances there is plain evidence of a fracture having taken place while the stone was as yet some distance from the earth. These surfaces of fracture are for the most part covered with a secondary coating which sometimes appears to have been partially formed by the pouring over of the melted surface matter from other parts. In some cases, however, the overflow is only traceable to a short distance from the edge of the fracture, and the remainder is merely discolored as if by smoke.

The want of homogeneity in the structure of the aerolites is shown in several cases by a sort of beaded circlet surrounding the stone. These circlets are composed of molten drops of iron and seem to lie nearly in a plane, and where this plane has been broken off by the fall it may be traced over the fresh surface by the presence of unusually large particles of nickeliferous iron.

For the following chemical analysis of a fragment of the meteorite I am indebted to Prof. J. Lawrence Smith: The Iowa County meteorite is of the more common variety, with a dull black coating, and having a rather light-gray color in the interior. It has numerous particles of nickeliferous iron disseminated through it, also particles of troilite. The specimen analyzed had a vein running through it which was much richer in iron than the mass to which it belonged. This meteorite has a hardness rather above the average of its class. I have found it to be composed of—

Stony matter	81.64
Troilite	5.82
Nickeliferous iron	12.54

Of the stony part there was—

Soluble in acid	54.15
Insoluble	45.85

Separate analyses of these gave:

	SiO_2	FeO	MgO	Na_2O	K and Li	Al_2O_3	
Soluble....	35.61	27.20	33.45	1.45	trace	0.71	=98.40
Insoluble..	55.02	27.41	13.12	1.01	trace	0.84	=98.42

This plainly shows that the principal constituent of the soluble portion is an olivine rich in oxide of iron, approaching hyalosiderite in composition, and that the insoluble part is pyroxene. The nickeliferous iron contained, besides traces of phosphorus, sulphur, and copper—

Fe	Ni	Co	Cu	P	S	
89.04	10.34	0.58	trace	trace	trace	=99.96

From an examination of an entire stone sent me after the completion of the above analysis, I have found the specific gravity to be 3.57.—Louisville, Kentucky, April 15, 1875, J. Lawrence Smith.

The first stone from the meteor that was found was discovered lying on the snow on the afternoon of February 15, and was adherent to snow and ice underneath. As the weather had been very cold from the time of the meteor-fall to the time of finding this fragment, it must have been warm enough when it fell to slightly melt the underlying snow, to which it was afterwards frozen.

I visited the spot shortly afterwards and found that it had first struck the ground more than 30 feet to the southwest of the place where it was found, making a slight indentation and bounding thence to the place where it finally came to rest. It was a fragment and showed a secondary coating of rather more than average thickness.

The other meteoric stones were not found until after the melting of the snow in the latter part of March. It is doubtless, owing to the frozen condition of the ground and the low angle of descent, that only a few of the larger pieces made any indentation in the earth, and we may therefore suppose that a much larger proportion of this meteor-fall has been secured than is usual.

The velocity with which the meteor moved can not be satisfactorily stated. According to the data just given the maximum would be about 10 miles per second, the minimum 3 miles. The most probable value for the last 60 or 70 miles of its course is from 6 to 7 miles per second according to the estimate of Mr. Christie, of Amana, who happened to be walking rapidly at the time the meteor appeared and continued for a distance of fourteen paces, when, having passed the corner of a building that threatened to obstruct his view, he stopped, and watching the meteor until it disappeared, and gave his estimate of the whole time at 10 or 12 seconds; and as he saw it through 60 or 70 miles of its path the resulting velocity would be as given above.

Gümbel[8] described the meteorite as follows:

On February 12, 1875, according to the statement of J. Lawrence Smith, in the State of Iowa, North America, about 10.30 p. m., there fell from a slightly cloudy sky, with a loud report, a widely visible meteor, which left a large number of stones. Smith estimated that not far from 150 kg. of stones were collected, of which 25 kg. came into the possession of Professor Hinrichs. To his kindness the Academy (Munich) owes a splendid specimen of not far from 1,500 grams weight, which afforded the opportunity for the following more accurate description of the constitution of this exceedingly noteworthy meteoric stone.

The Iowa meteorite belongs to the very common class of stones ordinarily designated as chondrites, or, according to Daubrée, to the subdivision of Sporadosiderites and in the group of Oligosiderites, classified as Professor Hinrichs, in the note accompanying a specimen of this stone sent to the Paris Academy, had already rightly noted and as Daubrée himself approved.

The somewhat sharp-edged, acute-angled, irregularly tetrahedral stone is covered with a black fusion crust, is of a light grayish-white color in the interior, and is supplied with numerous small black lumps and grains of meteoric iron and iron sulphide, and occasional small specks of rust. The stone is quite hard and can not be pulverized with the hand. It resembles in general character the meteoric stone of Pultusk, since like this, neglecting the meteoric iron and iron sulphide, it consists of a whitish and yellowish groundmass in which isolated olivine grains with a glassy luster appear, as well as sometimes darker, sometimes brighter, and occasionally opaque globules. Daubrée compared it to the meteoric stone of Vouille (May 13, 1831), and with that of Aumale in Algiers (August 25, 1865). By this fall the number of chondrites, already greatly predominating over all other sorts of meteoric stones, was again increased by one and the impression of the unitary origin of all these fragments from one former whole, which Meunier recently so strongly emphasized, was materially strengthened.

The exterior, sharp-edged, and angular form of the stones of this fall, which is but slightly obscured by the thin superficial fusion crust, points unmistakably to broken fragments of a larger mass of stone, which was caused by the shattering of an already fully prepared compact substance. That this dismemberment took place during the passage through the earth's atmosphere, is indicated by Smith's observation, who stated that many of the stones which fell looked as if they were freshly broken, and that the broken surfaces showed the beginning of fusion. There is, moreover, no rounding off, no flattening out or streaking, or twisting like a rope, such as a softer, more pliable body furnishes in moving upon a cosmic pathway or again such as it must receive in its flight from a volcanic eruption, like the papilli and volcanic bombs. The inner rough-grained constitution, moreover, shows no trace of glassy or lavalike particles which can not be made to correspond with a fusion of the mass by fusion-flame, and precludes all thought of a product of eruption after the manner of our volcanoes. The outward form and inner constitution of this sort of meteorite speaks accordingly, from the petrographic standpoint, against the supposition that these meteoric stones were cast out of the earth as the product of a powerful volcanic eruption. It is equally improbable that they originated from swarms of

shooting stars, principally because the time of the fall of the meteorite, so far as observation reaches, did not coincide with the time upon which the majority of the appearances of the shooting stars appear. Moreover, upon this supposition the great similarity in the composition of the meteoric stones could scarcely be explained. It becomes increasingly probable, therefore, that we have to do with fragments of celestial bodies, which originated from a shattering, either by collision or by disruption from some inner cause, whereby the momentum gained preponderance over the original gravitation and the fragments, having come into the range of the earth's attraction, must fall upon it. Whether they are portions of an asteroidal body, or, as Meunier will have it, of a second earth satellite, remains for astronomical discussion to decide, which is foreign to our subject here.

Crust.—The meteorite in question is covered all over, except for a small artificial abrasion, with a black, slightly wrinkled crust about 0.05 mm. in thickness and with a dull luster. This glassy coating is fissured and may be easily loosened from the mass, portions of the latter being, however, usually removed with it. There are to be seen in the interior of the stone in question no veins of matter like the crust, or smooth surfaces like those which are to be found so plentifully in, for example, the stones of Pultusk.

This crust, upon closer examination, consists of a scarcely transparent glassy substance which shows single refraction and occasionally incloses bubbles and pores, although not in so marked a manner as in the crust material of the Pultusk stone. The crust is not spread out over the surface of the stone in an entirely uniform manner; in some places meteoric iron particles appear with a metallic luster upon mild rubbing, in other places it is extremely thin and of a somewhat brighter color, or again thicker and more shiny. As shown by thin sections, the thin-crusted places correspond to the intrusion of olivine grains into the region of the crust, while where iron sulphide protrudes a thicker fusion crust is found.

On account of the depth of the coloring it is very hard to obtain the crust in transparent thin sections. This may be attained more readily by crushing small scales between two thin plates of glass. It shows then a deep bottle-green to brownish red color and behaves in polarized light like an amorphous glass. This characteristic confirms the conjecture that the crust was formed by the flight of the mass through the earth's atmosphere, producing a true fusion crust. For comparison, small scales from the interior of the stone were melted before the blow pipe, only in very thin fragments and the molten mass showed exactly the characteristics of the fusion crust, the same color, and the same bubbles. The stone behaved peculiarly when, without melting, it was subjected for a considerable time to a strong red heat. It took on thereby a dark brownish black color, and showed, upon cutting it open, isolated particles, which appeared as if melted. It is these borders of the pyrites which in fact suffered fusion. From thin sections of these heated particles, it is apparent that the greater part of the stone took on a deep brown color from heating, which, as I have elsewhere showed, yields a very good indication of olivine. The black borders of the particles of pyrites are almost opaque, of a deep brown color, and refract the light singly, exactly like the fusion crust. This dark color which the stone takes on by heating, a color which, on the natural stone itself, is never found deep under the fusion crust, indicates that the fusion heat confined its operation to an extremely thin layer of the exterior surface without subjecting the deeper portions of the stone to a higher temperature. In contrast with this phenomenon the veining of many meteoric stones of other localities is very noteworthy. In the case of the Pultusk stone, material from which was at my disposal, I found that these veinlets also consisted of an amorphous glassy substance. Of a similar sort seem to be the black, almost opaque specks which, in many meteoric stones, appear scattered through the entire mass and apparently furnish the borders around the more easily fusible ingredients; for example, pyrites.

I do not think, however, that the above-mentioned fine veinlets are molten material which has penetrated from the crust into the interior of the stone, but that at such places the stone was cleft or cracked, and that in these cracks, accessible to the atmosphere, the same fusion process by friction took place, just as upon the surface itself.

Stony mass.—The tolerably hard body of this stone, which can not be crumbled between the fingers, consists of a conglomerate of fragmentary particles, which are compacted together without any matrix, since neither a glassy nor other pronounced binding substance is to be seen between the individual grains. Small slivers of minerals with entirely irregular outlines are found in great numbers in the mass of the stone, as if they came from broken crystals or crystalline masses. Only very seldom—in thin sections—are pieces to be seen, which, being bounded by comparatively straight lines, may pass for small crystals or as ordinary cleavage products. Associated with the above are angular granules, which by their glassy luster and their color are quite readily determined as olivine, whitish particles of an opaque substance, small granules of bluish gray meteoric iron with a metallic luster, tombac yellow, much perforated lumps of iron sulphide whose fine grains sometimes form inclosed masses and ultimately even small rounded, now dark, now bright colored globules which give to the stone the character of Rose's chondrite. Dust-like particles, extremely fine and without metallic luster, are also found scattered or massed in small groups which are related to chrome iron, or a carbonaceous substance, since they offer resistance to every action of acid.

One of the most notable phenomena in the case of nearly all constituents of a metallic character, is that the individual fragments are penetrated by a surprising number of very fine to extremely fine cracks. In the case of many of the constituents there appears a certain regularity in the direction of these endless rifts, arising from a parallel direction of the cracks, which presumably bears a relation to the cleavage plane of the mineral in question. But at the same time, other cracks occur, besides those more regularly arranged, which cross the latter at right angles or diagonally, and produce a perfect network of cracks, so that even otherwise bright mineral particles are dimmed thereby. They must be regarded as an indication of shattering produced by concussion, pressure, or sudden change of temperature.

By reason of this cracked character of most of the constituents, the deeper interior character is often so obscured that it is rarely possible to make out, in the larger individual fragments, the apparently prominent bubbles, which,

so far as my observations go, are void of fluid content. Extremely fine, dust-like ingredients abound in the otherwise bright mineral particles, although true microliths seem to be wanting.

As to the mineralogical nature of the individual compounds, a large number of them are not related to pure minerals, but consist of stony fragments compacted together with several minerals, or a more or less regular conglomeration of different minerals.

Olivine undoubtedly takes the first place among the pure mineral particles. Not alone the outer aspect, the color, and the peculiar luster of the larger grains and crystal fragments, indicate olivine, but this determination is supported also in the decomposability of these fragments by hydrochloric acid, by the brown color produced by heating, and by the variegated play of colors upon the thin section in polarized light. Most of the fine-grained split particles consist of olivine, likewise many of the crystalline particles with regular boundaries and many even of the spherical concretions. But even in the dust-like interstitial matter, which seems to bind together the larger fragments, the olivine particles are noticeable, as is proved by the brown color produced by heating. Most notable is the olivine substance in many globules with feather-like markings, combined with a white, feather-striped substance, in lamellar concretions, as it occurs in the radiated fibrous globules. The small olivine scales come out very distinctly after heating, by their dark brown color. That they consist of an olivine substance is proved by treating with hydrochloric acid, whereby they are decomposed, while most of the interstitial lamellæ remain unchanged.

Feldspathic constituents can not be indicated with certainty, although individual colorless needlets in polarized light, show the peculiar yellow and blue colors so characteristic of feldspar, as they were observed with great distinctness in large quantity in the meteoric stones of l'Aigle (fall of April 26, 1803), which contained numerous stony fragments interlarded with feldspar needles. Likewise, the chemical analysis proves that at all events feldspathic particles are present in the composition in a very subordinate manner.

Tolerably fine powder treated for a considerable time with warm hydrochloric acid dissolves a large part of the stony mass—olivine part—with separation of colloidal silicic acid. In the residue, freed from silica by heating in alkali, may be seen very numerous, often colorless parallel-striped fragments, besides a turbid, powder-like remnant, which mostly comes from disintegrated globules. Likewise the fine, black granules, which occur here and there in groups remain undissolved, while the olivine, meteoric iron, and iron sulphide dissolve. The more or less translucent portions, which remain undissolved, have a double fracture and show beautiful colors in polarized light. If this remnant be treated still further with hydrofluoric acid, it dissolves completely, except the fine black granules which pertain to chrome iron or carbon. Since in the dissolution of the stony mass by means of anhydrous barytes, it gives a chrome content, it is highly probable that the black granules are chrome iron. Indeed, I frequently observed, upon heating the powdered stone, a sporadic glimmering as of carbon particles, but I was uncertain whether this did not come from dust particles which did not originally belong to the stone, but were only foreign bodies, mechanically added. If the experiment be changed, so that sections of the stone just thin enough to be quite transparent are first heated in hydrochloric acid, the sections still maintain their cohesion. Placed upon a glass plate and carefully treated with caustic potash in order to remove the free muriatic acid, the preparation presents a porous appearance, the olivine, meteoric iron, and iron sulphide having disappeared, while the white metal and most of the globules remain unaltered. If the preparation so obtained be examined in Canada balsam with a cover glass to protect it, it falls to pieces under the slight jar caused by putting on the cover glass, and the mass appears as isolated heaps of the white mineral, in separate flakes and round globules which often appear quite free. Moreover, small, light garnet-red bodies in quite regular 5 to 6 sided forms make their appearance, very sparingly, in the thin section. They resemble garnets, but are found to possess double refraction. Color also suggests nosean, but the optical character does not agree with this mineral.

Concerning the nature of the mineral particles undissolved by the hydrochloric acid, which probably belong to the augite group, only chemical analysis can give any information. But here also much uncertainty exists on account of the presence of numerous globules likewise insoluble in hydrochloric acid (disregarding the olivine grains) which are neither identical with the white mineral, nor exactly analogous to a pure mineral. Many of these globules approximate, in their physical characteristics, the white mineral, but yet show a peculiar sort of fissuring. Others plainly consist of lamellæ of various compound minerals, and still others are slightly transparent and white powdery-grained, and frequently show a concentric structure with darker and brighter zones. Often, also, they have a crust-like, dark envelope or a partly dark or partly bright center. Black dust-like granules, which occur in the above chondri are for the most part concentrically arranged. Yet these chondri are not amorphous, since their refraction in polarized light is distinctly colored. The most notable of these chondri are those which appear with very fine radial markings, fine-grained, slightly transparent, and of whitish color. The radial markings are eccentric and do not correspond in any way with the outer form of the chondri. Several systems of marking frequently occur side by side in the same chondri. In polarized light, despite the slight transparency, the colors appear in fascicles, which is slightly suggestive of the well-known phenomenon in connection with many variolites. The lamellar combination of olivine-like strips with a similar fibrous, white substance, has been described above.

Concerning the origin of this most notable ingredient of meteoric stones, Daubrée conjectured that it was formed by solidification during a rotary flight through gases, while Tschermak favors the view that it was produced by the rounding of previously solidified fragments through prolonged agitation as would take place in a volcanic explosion, as described by Gleichenberg and others in the case of similar round globules in trachyte tufas. This latter conjecture explains the peculiarity noted in many chondri that their inner fibrous structure has no connection with the outer spherical form. Even in the case of the chondri with distinctly concentric structure, this manner of origin may be

maintained, if we assume, as is very probable, that the concentric stripes and markings are to be regarded as merely secondary phenomena, sequences of mechanical and chemical alteration, which the rounded lump underwent after the rounding.

Iron sulphide plays an important part in the composition of the Iowa stone. It seems to be distributed in small irregular patches as if forced in between the other ingredients. By treating the pulverized stone with hydrochloric acid, hydrogen sulphide is developed, without the separation of sulphur. This iron sulphide may therefore be regarded as troilite. The meteoric iron grains of the stony mass appear to be abundantly compacted in jagged, angular lumps, frequently running out into fine points which cling as closely to the nonmetallic portions as if the iron was first separated by reduction on the place where it originated (?). This meteoric iron contains nickel and some sulphur, is very malleable, as it can be readily hammered out into thin leaves; is active, as proved by the fact that when a shaving is immersed in blue vitriol, the iron surface is quickly coated with a copper deposit. Whether Widmannstätten figures appear upon etching can not be determined definitely on account of the smallness of the iron grains. Yet darker and brighter specks do appear.

That the stone contains water, requires no proof beforehand, since this is demonstrated already by the presence of rust specks, hydroxide of iron.

The specific gravity of the stone in the interior is 3.75; that of the crust portion 3.55 (at 20° C.).

I had at my disposal for the chemical analysis of this meteorite something over 1.5 grams of material. From the finely pulverized portion the meteoric iron was first carefully abstracted with the magnet, and this was then freed as carefully as possible by repeated treatment from all adhering stony matter and examined by itself. One portion served for the determination of the sulphur, the remainder was first treated with boiling hydrochloric acid, the portion dissolved in this way and likewise the undissolved portion isolated by means of barium hydrate, and further analyzed. The analysis gave the following results.

The stone consisted of:

Meteoric iron	12.32
Troilite	5.25
Soluble in hydrochloric acid	48.11
Insoluble in hydrochloric acid	34.32
	100.00

The nickel-iron contained—besides traces of copper and sulphur, the latter evidently from adhering troilite:

Iron	83.38	Approximating Fe_8Ni.
Nickel (containing some cobalt with sulphur and phosphorus)	16.62	
	100.00	

The soluble portion (without reckoning the meteoric iron and iron sulphide) contained:

		Oxygen.	
Silicic acid	38.38	19.76	19.51
Iron protoxide	28.58	6.33	
Manganese protoxide	0.53	0.12	
Magnesia	31.49	12.59	
Alumina	1.01	0.47	
Lime alkalies, water	Trace.		
	99.99		

The insoluble portion contained:

		Oxygen.	
Silica	53.96	28.74	29.68
Alumina	2.01	0.94	
Iron protoxide	25.18	5.57	10.29
Magnesia	8.91	3.56	
Lime	4.04	1.16	
Manganese protoxide	Trace.	.....	
Chrome oxide	1.42	1.16	
Soda	2.39	0.59	0.88
Potash	1.67	0.29	

As to the meteoric iron and pure iron sulphide, it requires no further place here.

In the portion soluble in hydrochloric acid there was an oxygen proportion of the base and the acid of nearly 1:1, and it also requires no further demonstration to show that this portion is certainly derived from an olivine rich in iron protoxide. The explanation of the insoluble residue is much more difficult, as its constituents and oxygen proportion agree with no definite mineral. This agrees perfectly with the optical analysis according to which, after the removal of the soluble portion, it contained, besides the spherical chondri in various characters, a bright mineral, much cracked, and small black granules. That the latter consisted of chrome iron is, according to the results of the analysis,

no more to be doubted. The bright fissured mineral evidently belongs to the augite group. The high percentage of iron protoxide is very unusual, even when we allow for a corresponding portion as united with chromium oxide to form chromite. On the other hand, the small amount of magnesia and lime is noticeable, in contrast. The high percentage of alkali appears to have more bearing upon the composition of the chondri and to point to a feldspathic constitution. If, as appears probable, the alumina belongs to the compound with the corresponding quantity of silicic acid, a corresponding composition of an augite rich in iron appears, such as occurs in the eukrites; for example, that of Juvinas. The exact nature of this augitic compound always seems hard to ascertain. Although the analysis of the Iowa meteorite which J. L. Smith contributed does not agree exactly with the foregoing, still even in this there is an unusually high percentage of iron protoxide in the insoluble portion.

The chondri have found no more consideration, since they can not, without further investigation, be regarded as as composed of augite.

Among chondri thus far analyzed, only that of Tadjera has a similar composition, although poorer in silica and rich in lime.

If the data of all the investigations of this meteorite be combined, they give rise to the following conclusions:

1. The stony matter consists of irregular splinters of olivine and an augitic substance, which appears to be derived from one disintegrated stone. There also appears to be a feldspathic substance present in small quantities. Finely pulverized particles of this mineral apparently furnish the cementing medium.

2. The roundish chondri compose, besides the mineral particles alluded to, a considerable portion of the substance of the stone. Sometimes they are connected with the olivines, and sometimes they present lamellar intergrowths of minerals, or consist of radiated fibrous masses. A portion of them seem to consist of a feldspathic substance. Their form is due to mechanical abrasion.

3. The meteoric-iron grains are so situated between the mineral splinters and the chondri that they appear to have originated by reduction subsequent to the formation of the stone.

4. There are no glass or lavalike constituents (the fusion crust excepted) in the stone. This is not a rock crystallized out of a fused mass, but a clastic one whose constituents do not have the character of a volcanic ash.

Wright [9, 10] repeated his previous observations on the gases of the meteorite, but reached no especially new conclusions.

Wadsworth [11] gave an optical study of the meteorite, as follows:

The specimen of this meteorite in the Harvard College cabinet presents a fine-grained groundmass, sprinkled with pyrrhotite and iron. On the polished section it shows a well-marked chondritic structure.

Specimens of this meteorite were purchased for the Whitney lithological collection of the Museum of Comparative Zoology from Ward and Howell, Rochester, New York, and sections made. The sections are colored gray, with patches of brownish-yellow staining from the iron. The gray groundmass contains irregular detached bits of metallic iron, about which the stain extends. The groundmass is composed of crystals and grains of olivine, enstatite, pyrrhotite, iron, and base. The section shows the usual chondritic structure, in which granules of olivine and enstatite are cemented by the base to form the chondri. I can find no evidence either in this or in any other meteorite that I have seen that they are *fragmental* in character, but rather evidence that the structure usually observed is the result of *rapid cooling* upon a *liquid magma* of this constitution. * * *

The base in this peridotite varies from a light to a dark ash-gray, and is fibrous granular in its structure. The darker shades are generally associated with the olivine and the lighter with the enstatite. Various gradations are seen between that state of the base which does not affect polarized light and that which shows feeble coloration—properly not a base. These gradations are owing to the differentiation in it of more or less granules of olivine or enstatite, causing the depolarization of the light. The feeble polarization appears to be owing to a differentiation of the base so as to leave but minute portions of it in the original state, although the differences between the two states is not noticeable in common light. The tendency of these granules is to unite into a homogeneous crystal, the base disappearing more and more, according to the conditions attending the solidification of the mass. Furthermore, as in other rocks, so in this, the base should be expected to be one of the first materials, after the iron, to suffer alteration. The writer supposes this base to be that which other writers have described as the matrix of fine dust, formed by the comminution of the meteoric material; flocculent, opaque, white mineral; also as feldspathic material, etc.

A series of grains and crystals of olivine, arranged in spherical form and cemented by the *fibrous-granular* base, forms the olivine chondri. I do not regard these as rounded forms owing their form to mechanical action, for no abrupt line separates them from the surrounding material, as is the case where detached fragments are inclosed in a matrix. In the same way the granules themselves show that they are products of crystallization, and not broken fragments held in the matrix; everything points to crystallization in a more or less rapidly cooling body. In some instances it is indeed true that an abrupt termination exists to some of the forms, but these appear to be fragments of base, sometimes partly differentiated, caught in the liquid mass, instead of mechanical forms torn from some previously existing rock.

This meteorite has also been described by Lasaulx, who states that it shows an evident brecciated structure, with olivine grains and rounded enstatite masses, in a fine-grained groundmass, containing grains and fragments of crystals, as well as iron and pyrrhotite. Plagioclase is said to be present, and the base is described as a gray, fine-grained, aggregate, cementing mass, resembling the granular microfelsitic groundmass of many porphyries.

Tschermak [12] illustrated some of the chondri of the meteorite.

Brezina [13] in 1885 classified the meteorite as a brecciated gray chondrite and described the Vienna specimens as follows:

Of Homestead the cabinet possesses a dark green complete, breccialike stone of 810 grams, the same of which the Bonn Museum received a piece in exchange and of which Lasaulx published a series of microscopical investigations.

Judging from the fracture and overlooking the hardness of this stone one would take it for a serpentine. The section exhibits the richness of the stone in grains of iron, which are so abundant in places that the stone takes on the appearance of a fine-grained mesosiderite. A large slice in the collection of Braun is half dark gray, the other half bright gray, and the two colors gradually shade into each other. A piece in the Vienna Museum (obtained by exchange from Otto) shows a dull, medium dark gray color, while another in the same collection, received from Hinrichs, shows a bright gray. So long as nothing definite is known concerning the frequency of the occurrence of this change, it seems most appropriate to place the stone among the brecciated variety. The first mentioned dark green piece is also distinguished by the absence of a proper crust, although the original surface is unmistakable on account of the pronounced pitting and lustrous appearance of the exterior in comparison with the interior.

In 1895 [14] he described another individual as follows:

A nearly complete individual of this fall (in the Vienna Museum) of 1,070 grams weight shows a very pronounced orientation; the elongated front face having, around the apex, a denudation 1 cm. in size showing a rusted groundmass beneath, has a black crust, pittings, and marked lines of flow upon the crust. The opposite rear side, inclined at an angle of about 50° to the front side, has a dull, finely granular, sometimes finely porous, thick crust with white crust lumps near one edge. A second rear side, inclined at an angle of some 70° to the front side, has a coarse, hackly, barklike crust, which shows lines of flow running over the edge on the side toward the front face. In the opposite direction it becomes swollen and shining. A third side, or rear face, inclined at an angle of about 60° to the front face, shows only on the side toward the front face, as also a little on the side toward the two rear faces, a very loose, porous, barklike crust, which is abruptly broken off toward the inside and is only represented on the inner portion of this face by numerous bubbles, while the greater part of the face is only very slightly glazed. A fourth side face, at right angles to the front side, appears to be a terrestrial, or at least an entirely unfused, fresh fracture. A fifth side, or forward face, inclined at an angle of 120° to the front side, shows an armor face and considerable rusting. A flat slice of this mass shows, in addition to both roundish and angular chondri of white and gray colors, a metallic vein 1 to 1.5 mm. thick, apparently noncoherent, which is also visible through the crust.

Hinrichs [15] published in 1905 a pamphlet describing, to some extent, the distribution of the stones among collectors and museums, and urging the adoption of the name Amana instead of that of Homestead.

The meteorite is widely distributed, both in the form of sections and individuals. Yale has 35 kgs.; Harvard, 17 kgs.; Field Museum, 12 kgs.; and the University of Iowa, several individuals.

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Honduras. See Rosario.

HOPEWELL MOUNDS.

Ross County, Ohio.
Iron. Medium octahedrite (Om) of Brezina.
Prehistoric; described 1902.
Weight, 130 grams (5 ounces).

This meteorite was described by Farrington [1] as follows:

Among the objects obtained from the Hopewell Mounds of Ohio, and now in the anthropological collections of the Field Museum are a number made of iron. These include a part of a head and ear ornament, some celts, a number of beads, and lastly a small unwrought mass weighing about 130 grams (5 ounces). Dr. G. A. Dorsey, to whom I am indebted for calling my attention to them, informs me that they were all found associated with a single human skeleton near an altar of one of the mounds. They were considerably oxidized, so that the original metal is in most cases obliterated, but the unwrought mass above mentioned was found to be oxidized only on the surface. A qualitative analysis of some filings from this mass showed the presence of nickel, and indicated, as might be expected since no other source of iron probably lay open to the Mound Builders, that the objects were made of meteoric iron. Upon removing the rust from one surface and submitting the area so exposed to the etching action of nitric acid, the meteoric nature of the iron was proved beyond question by the appearance of Widmanstätten figures. The nature of these figures is shown by figures where the structure of bands of kamacite separated by thin ribbons of tænite can be plainly discerned. The width and continuity of the kamacite bands varies considerably. Some are at least 1 mm. in width and from these they grade down to not over twice the width of the corresponding tænite ribbon. While many are continuous in a general way for a length of from 10 to 20 mm. the tænite runs through them all in a series of anastomosing branches, and in places gives the impression of a network in which grains of kamacite are embedded. The contour of the figures is for the most part curved and wavy, especially near the borders of the section. The most reasonable explanation for this seems to be the treatment probably given the mass by the ancient workmen. If heated until it became somewhat plastic and then hammered, just such curving of the plates might be produced. Owing to the distortion of the figures it is impossible to positively classify the iron. Apparently it is an octahedral iron having lamellæ of medium width. While two alloys, kamacite and tænite, are plainly discernible, no troilite or schreibersite can be seen, although the presence of the two latter is indicated by the percentages of sulphur and phosphorus found on analysis. At one end of the mass are three large irregular pores such as might have been produced by the falling out of crystals of chrysolite or other stony matter. There is no other evidence, however, that such stony matter was at one time present and the cavities may have been produced in a purely mechanical way. This seems rather the more probable from the fact that the rest of the mass is quite compact. The iron is rather soft, cutting easily with a hack-saw, and malleable. It is active to copper sulphate.

For purposes of quantitative analysis a small piece was sawed from one end of the mass and cleaned from rust by filing and scraping. The analysis, made by Mr. H. W. Nichols, and using the methods adopted for the Los Reyes meteorite, gave the following results:

Amount of substance taken, 2,166.3 grams.

Fe	Ni	Co	Cu	Mn	Sn	S	P	
95.20	4.64	0.404	0.035	Trace.	Trace.	0.13	0.07	=100.48

The other meteorites known to have been found in Indian mounds of this country are those of Oktibbeha County, Mississippi, and the Turner Mounds, Ohio. In the Oktibbeha County iron the quantity of nickel reaches 59.7 per cent, and this sufficiently distinguishes it from any other known meteorite. The Turner Mound meteorites include masses from two different mounds, which were analyzed by Kinnicutt with the following results:

	From Mound No. 3.		From Mound No. 4.
	1	2	
Fe	86.66	88.37	89.00
Ni	12.67	10.90	10.65
Co	0.33	0.44	0.45

It will be remembered that Kunz concluded from a comparison of the Turner Mounds meteorites with those of Kiowa County, Kansas, that on account of the marked similarity in constitution and structure they belonged to the same fall. The Hopewell Mounds are only about 75 miles distant from the Turner Mounds in an easterly direction, and it might be expected that the same meteoric iron would have been used for the construction of the objects found in these mounds. The results of the analysis above given do not, however, permit this conclusion, the differences in the percentages being greater than are known to occur among the individuals of a single fall. Comparison of etching figures is out of the question on account of the distortion of those of the Hopewell Mounds specimen, but the lack of any content of chrysolite such as characterizes the Turner Mounds masses is a further point of difference. It seems impossible at present, therefore, to connect the Hopewell Mounds mass with any known meteorite, and the specimen will therefore be designated as the Hopewell Mounds meteorite.

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HOPPER.

Henry County, Virginia.
Here also Henry County.
Latitude 36° 54′ N., longitude 76° 5′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1889; described 1890.
Weight, 1.92 kgs. (4 lbs.).

This meteorite was described by Venable [1] as follows:

This iron was found by Nathaniel Murphy in Henry County, Virginia, about 4 miles from the Pittsylvania County line, and 0.5 mile north of the dividing line between North Carolina and Virginia, near to Smith River. Murphy found the stone in a plowed field in the latter part of the spring of 1889. He gave it to Col. J. Turner Morehead, of Leaksville, North Carolina. Together with Colonel Morehead he searched over the farm, but could find nothing similar to his piece. Colonel Morehead sent the mass to Dr. H. B. Battle, of Raleigh, North Carolina. It weighed 1.7 kg., and the detached pieces, mainly crust, weighed 0.22 kg. This crust broke off along certain lines by a kind of cleavage, and the main mass is permeated with cracks, not irregular and zigzag, but distinct and regular. This cleavage is in two directions. The laminæ vary in thickness, but many are about 0.5 mm. The color of the surface is dark bluish-black, mixed with much red rust coming from the lawrenceite. Parts of the soil apparently still cling to the mass. It measured 60 by 70 by 75 mm. in its greatest dimensions. Here and there spots were to be seen with bright silvery sheen. It contains a good deal of ferric chloride and crumbles rapidly. Coarse Widmannstätten figures appear on the polished surface without etching.

The analysis gave:

Fe	Ce	SiO_2	P	Co	Ni	
90.54	0.35	0.04	0.13	0.94	7.70	=99.70

Farrington [2] suggested the name of Hopper for the meteorite because of the nearness of its place of find to that town. This suggestion has been adopted by later cataloguers.

The meteorite is distributed.

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Howard County. See Kokomo.

HUEJUQUILLA.

Under this title various Mexican iron meteorites have been included at different times, especially those of the State of Chihuahua. Wülfing includes the following: Chupaderos, Adargas, Morito, Rio Florido, Sierra Blanca, and Tule. The first three may be found under their corresponding names in the text of this catalogue, while the last three refer to irons that have apparently been lost.

HUMBOLDT IRON.

Alexander von Humboldt brought to Europe in 1811 a piece of meteoric iron which he stated to have been taken from an unusually large mass of iron, 15,000 to 20,000 kg. in weight, found in the neighborhood of Durango. The large mass he did not see himself. Pieces of Humboldt's piece have been distributed in collections under the name of the Humboldt iron, but the original mass from which they came has never been identified.

It is possible that this larger mass was Morito or one of the Chupaderos masses, but the origin of the Humboldt iron is so uncertain and obscure that there seems no desirable end to be served in continuing the designation.

ILLINOIS GULCH.

Deer Lodge County, Montana.
Latitude 46° 30′ N., longitude 114° 45′ W.
Iron. Nickel-poor ataxite, Rafruti group.
Found 1897 (Ward), 1899 (Preston); described 1900.
Weight, 2,450 grams (5.4 lbs.).

This meteorite was first described by Preston,[1] as follows:

The Illinois Gulch siderite was found in Illinois Gulch, Deer Lodge County, Montana, in 1899, on the bedrock about 4 feet below the surface, by J. Parle while placer mining.

The mass was somewhat ham-shaped.

Its dimensions are 63 by 104 by 105 mm. in its greatest diameters. There are two rather large typical pittings, one on either side, with numerous quite small ones and three sharp angular ridges on the upper or necked surface. But little genuine crust is left, the bright silvery metallic iron being visible in small patches through the oxidized surface, over a portion of the mass.

On certain portions of the mass, particularly in the deeper pittings, there is quite a thick deposit of carbonate of lime, showing that it had lain for a long time in the position where found.

In slicing the mass into five sections, the protosulphide of iron, troilite, was found only on one section, and on this in very small quantities; the largest nodule being only 6 mm. in diameter, with numerous small fissures, from 1 to 5 mm. in length, extending in various directions from it, that are filled with the same material.

This nodule occurred in the lower center of the section. At the extreme right, within 5 mm. of the edge of the section, occurred another patch of small fissures, covering an area of about 8 mm. in diameter, filled with troilite.

On etching the iron no distinct figures of any character were brought out, but a surface of a dark gray groundmass was left filled with bright silvery-white flakes, without any definite form, or sharp line of contact, between them and the dark gray groundmass.

Over the surface are scattered in single crystals, occasionally in groups, a very dark steel gray crystallization, from 0.5 to 1 mm. in length and 0.5 mm. or less in width, that are probably the phosphide of iron and nickel, rhabdite.

The character of the etched surface of this iron is more nearly, lacking the supposed rhabdite crystals, like the Morradal, Norway siderite, than any other with which I am acquainted.

This mass is in the possession of Ward's Natural Science Establishment, and when received by them weighed 2,435 grams, but at that time a fragment weighing possibly 15 grams had been chiseled off the end of the narrow neck.

An analysis of this siderite by Mariner and Hoskins, of Chicago, gave:

Fe	Ni	Co	Si	P	C	
92.51	6.70	0.16	trace	0.62	0.01	=100.00

Specific gravity, 7.7.

This meteorite will be designated the "Illinois Gulch" meteorite, Deer Lodge County, Montana.

Ward [2] describes a section in his collection weighing 830 grams as follows:

End piece, 58 by 58 by 100 mm. Face polished, back exterior of mass. Etched face shows no figures but a series of indistinct bright plates associated with a darker colored iron, with an obscure mark of contact between them. Over this surface are a number of brighter small crystals which are probably rhabdite. The section shows two troilites, one 6 mm. in largest diameter, with numerous small fractures or fissures extending in various directions from it, which are likewise filled with troilite.

Cohen [3] reviewed previous notices and described a section of 35 sq. cm., as follows:

Illinois Gulch assumes a flecked appearance after etching, since it is composed of irregular, jagged, generally isometric grains of 0.25 to 1.5 and occasionally even 3.5 mm. often quite indistinctly divided off from one another, every part of which shows at the same time a brightly glistening reflection. An etched surface shows great resemblance to that of Forsyth, although in the latter case the size of the grains is somewhat smaller and more uniform, and their demarcation more distinct. While in the case of Forsyth, under the microscope, each large grain is distinctly seen to be composed of smaller, even, well-defined granules, the grains in Illinois Gulch appear on high magnification to be covered with crowded, uniformly distributed etching pits 0.01 mm. in size and somewhat elongated and of quite irregular form, which produce the luster, and under the microscope impart a dappled appearance to the grains.

With a low magnifying power one sees only a few small granules resembling schreibersite; with a higher power spindle-shaped inclusions as much as 0.2 to 0.4 mm. long come to view, which perhaps likewise belong to schreibersite. Other accessory constituents were not recognized, and according to the description of Ward they seem to occur only in small quantity.

Analysis by Fahrenhorst:

Fe	Ni	Co	Cu	Cr	S	P	
86.77	12.67	0.81	0.02	0.01	trace	0.08	=100.36

Specific gravity, 7.8329.

Mineralogical composition:

Nickel-iron	99.48
Schreibersite	.52
	100.00

The analysis by Mariner and Hoskins, contributed by Preston, gave such an entirely different result that it could scarcely be the same meteoric iron that was analyzed.

The meteorite is distributed, Ward possessing 830 grams, and the British Museum 637 grams.

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Independence. See Kenton County.

Independence County. See Joe Wright.

INDIAN VALLEY.

Floyd County, Virginia.
Here also Floyd County, Floyd Mountain, and Radford Furnace.
Latitude 36° 55′ N., longitude 80° 30′ W.
Iron. Brecciated hexahedrite (Hb) of Brezina.
Found 1887; described 1891.
Weight, 14.2 kgs. (31 lbs.).

The first account of this meteorite was by Kunz and Weinschenk [1] in 1891, as follows:

This iron meteorite was found in the spring of 1887 by Mr. John Showalter while plowing his tobacco patch in Indian Valley, near the base of the south side of Floyd Mountain and 6 miles southeast of Radford Furnace, Virginia. Search in the near vicinity for other pieces was without success. This meteorite weighs 31 pounds (14 kg.) and measures 28 by 20 by 13 cm. (11 by 8 by 5 inches). The surface of the iron is very much corroded and is entirely covered with a rust crust; only a little of the original crust is visible. On the exterior are deep impressions from 2 to 4 cm. in diameter. The iron has a crystalline structure and evident cubic cleavage on account of which pieces readily fall away.

The following analysis was made by Mr. L. G. Eakins, in the laboratory of the United States Geological Survey:

Fe	Ni	Co	Cu	P	S	Si	
93.59	5.56	0.53	trace	0.27	0.01	trace	=99.96

The same, calculated to 100, after removal of the schreibersite as $NiFe_2P$, and of the troilite as FeS, gives:

Fe	NiCo	
94.31	5.69	=100.

The structure of this iron meteorite possesses a superior interest since it is a mean between the so-called breccias (better designated as granular irons) and the cubic irons consisting of one crystal individual. On even an unetched surface can be seen in considerable quantity rodlike crystals 1.5 by 5 mm. in dimension, which possess the properties of schreibersite—high luster, tin-white color, brittleness, and insolubility in solutions of copper salts. These appear to be arranged on the section in straight, parallel bands, across whose direction the crystals stand parallel among themselves. On an etched section one sees that these directions are parallel to the Neumann lines, which, on a large portion of the section, are formed as completely as in Coahuila. Occasional spots, larger or smaller, however, possess a purely granular structure. The appearance is quite identical with that of the iron from Chatooga County and not very different from that obtained by etching a piece of cast iron. In addition, there extend over the whole section characteristic, not definitely oriented, and partly bent sheen bands such as we have never as yet noted on any other iron meteorite. It may also be observed that toward the interior of the iron the granular, and toward the exterior the unitary portions predominate.

The structure of this iron perhaps allows some conclusions to be drawn regarding the origin of the cubic structure of iron meteorites. It seems to us that the granular portion shows the original structure from which by metamorphism the other has been formed. The result of the analysis shows an unusually low percentage of Ni+Co, and one below the normal average for cubic irons. This would seem to indicate that the granular portions contained less nickel than the crystallized. The former then did not possess the capability of crystallization which nickel-iron composed of kamacite, tænite, etc., possesses. Sufficient material is not at hand to settle this question, but in every respect the iron of Floyd Mountain seems to be one of the most interesting which has appeared in recent years.

An abbreviated form of the above account was published by the same authors in the American Journal of Science the next year.[2]

Brezina [3] raised the question whether this meteorite belonged to Hollands Store.

Berwerth [4] characterized the iron as "kamacite (hexahedral iron) with zones of octahedrally oriented grains."

Farrington [5] placed it among the hexahedrites, since he did not consider the granular particles essential; he also mentioned two small troilite nodules.

Cohen [6] thought with regard to the question raised by Kunz and Weinschenk as to the origin of the peculiar structure, that either the granular portion was the original from which, by later crystallization, the unitary portions arose, or that a low content of nickel in the granular portions gave low crystallizing power. He calls attention to the fact, however, that the content of nickel, instead of being low, corresponds with that of other hexahedrites. He also criticises Berwerth's classification of the meteorite as not agreeing with his description. If Berwerth means, he states, "that the zones run parallel to the octahedral surfaces then the meteorite would not be a granular hexahedrite, to which, however, it was referred by Berwerth."

The meteorite is more than half (8,085 grams) preserved in the Field Museum collection.

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Iowa County. See Homestead.

Irapuato. See La Charca.

IREDELL.

Bosque County, Texas.
Latitude 31° 53′ N., longitude 97° 52′ W.
Iron. Normal hexahedrite (H) of Brezina.
Found 1898; described 1899.
Weight about 1,500 grams (3.3 lbs.), of which only about 500 grams (1.1 pounds) were preserved.

The history and characters of this meteorite have been summarized by Cohen [2] as follows:

According to Foote,[1] this iron was found in 1898 in a rut 7 inches deep in an old road on the Dudley sheep ranch, 5 or 6 miles southwest of Iredell in Bosque County, Texas. It had originally the shape of a large mussell-shell but was broken up into many pieces, and among other things, had been used to replace knife blades. Scarcely a third (500 grams) of the original mass, in the form of angular fragments with rusty exterior, can have been preserved; it shows a slight exudation of iron chloride. The occasionally prominent cleavage is explained as dodecahedral. The bright tin-white iron is soft and takes a fine polish; upon etching numerous very small depressions and fine bright lines appear which, for the most part, cross at right angles, but which also occasionally run diagonally. Friable, magnetic schreibersite is plentiful in grains and plates 2 mm. in breadth.

Analysis (Whitfield):

Fe	Ni	Co	P	S	
93.75	5.51	0.52	0.20	0.06	=100.04

A small piece which I investigated shows a generally irregular rust-covered exterior, besides one freshly-opened surface which is generally even but in places is here and there marked off *en échelon*, so that the cleavage may with reasonable certainty be assumed to be hexahedral. Immediately after weak etching numerous uniformly-distributed pittings as much as 0.01 mm. in size, and fine-line systems appear, closely resembling the etching pits and Neumann lines of other hexahedrites. After stronger etching each pit becomes enlarged and between them occur very many

finer points which I regard likewise as etching pits; the etching lines do not appear to increase. The distinct but not very lively oriented luster increases in intensity by streaks and the stripes are twisted, owing to a distortion of the structure in the forcible removal of the piece. Of accessory minerals there are only a few rods and grains of schreibersite to be mentioned.

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IRON CREEK.

Province of Alberta, Canada.
Here also Battle River, Saskatchewan River, and Victoria.
Latitude 52° N., longitude 112° W.
Iron. Medium octahedrite (Om) of Brezina.
Described 1872.
Weight, 175 kgs. (386 lbs).

The first published mention of this meteorite seems to have been by Butler [1] whose account of it is thus reported by Flight:[2]

In 1870 Captain Butler received orders from Lieut. Gov. Archibald, of Manitoba, to proceed on a mission to the Saskatchewan. While returning from the far west he passed, on December 25, 1871, through the village of Victoria, which lies on the north branch of the river about midway between Fort Edmonton and Fort Pitt, and was shown in the farmyard of the mission house of that station a curious block of metal of immense weight. It was rugged, deeply indented, and polished on the edges by wear and friction. Longer than any man could say, it had lain on the summit of a hill out on the southern prairies. It had been a medicine stone of surpassing virtue among the Indians far and wide, and no tribe or member of a tribe would pass in the neighborhood without visiting this great medicine. It was said to be increasing yearly in weight. Old men remember to have heard old men say that they had at one time lifted it easily from the ground; now no single man can carry it. Not very long before Captain Butler saw this meteorite it had been removed from the hill upon which it had so long rested and been brought to Victoria. When the Indians found that it had been taken away they were loud in the expression of their regret. The old medicine men declared that its removal would bring great misfortune, and that war, disease, and dearth of buffalo would afflict the tribes of the Saskatchewan. This was not a prophecy made after the outbreak of smallpox which was devastating the district when Captain Butler was there, for in a magazine published by the Wesleyan Society of Canada, there appears a letter from the missionary announcing the predictions of the medicine men a year before Captain Butler's visit, and concluding with an expression of thankfulness that their dismal prognostications had not been realized. A few months later, however, brought on all three evils upon the Indians. Never, probably, since the first trader had traversed their land, had so many afflictions of war, famine, and plague fallen upon the Crees and the Blackfeet as during the year succeeding the removal of their Manitou stone from the lone hill top upon which the skies had cast it.

Coleman [2] states that the meteorite was brought in (presumably to Victoria) in 1870 by Red River cart by Daniel McDougall at the instance of his father, Rev. Geo. McDougall. Coleman [3] further states:

It was found on a hill near Iron Creek, a tributary of Battle River, at a point about 150 miles south of Victoria, on the North Saskatchewan.

This meteorite was greatly venerated by the Indians, who made offerings to it of beads, trinkets, or knives before setting out on hunting or warlike expeditions. They saw in the markings on its surface the rough features of a face, believed that the "stone" attracted lightning, and that it had grown in size and weight since they first saw it.

In outline it is irregularly triangular and much broader than it is thick. Its surface shows the usual rounded and pitted appearance. It consists of solid metal, with scarcely a trace of stony matter and only a slight oxidation of the surface. Specific gravity: 7.784.

Analysis (Coleman):

Fe	Ni	Co	
91.33	8.83	0.49	=100.65

Brezina [4] described the structure as follows:

Victoria has a very regular zone of alteration 3 mm. broad, even under the 0.5 to 1 mm. thick crust of the rear side. The lamellæ are long, straight, partially grouped, not swollen; the kamacite finely hatched and spotted. Tænite well developed. Fields abundant, resembling the kamacite, but with finer structure or with tænite spots instead of combs.

Farrington [5] described the form of the meteorite as follows:

A cast of this meteorite recently received by the Field Museum, through the kindness of the Geological Survey of Canada, affords an opportunity for the study of some features which have not previously received description. The meteorite is remarkable for its orientation, the characters of front and rear sides being shown very plainly. In perfection of form in this respect it equals the Cabin Creek meteorite, which in general shape it resembles. In previous descriptions of this meteorite it has merely been stated that the mass was "irregularly triangular and much broader than thick," and no dimensions have been given.

The form of the Iron Creek meteorite, as seen from its cast, is that of a low cone, 8.5 inches (22 cm.) high and 22 inches (56 cm.) in diameter. The outline of the base of the cone is an incomplete circle, an approximately straight contour cutting off one side so that only about three-fourths of the circle is present. The width of the mass in this direction is 17 inches (43 cm.). Were the circle complete the apex of the cone would occupy a position near its center, but with the mass shaped as it is, the apex is situated close to the straight side. At one point where the straight side joins the circular outline there was evidently in the original mass a prolongation perhaps a few inches in length, which, having formed the most convenient part of the meteorite for removal, has been sawed off for purposes, doubtless, of analysis and distribution. While the form of the meteorite as a whole is conical, it is also arched, the base being concave and the sides convex. The greatest depth of the concavity of the base is about 1½ inches, and occurs opposite the apex. This general concavity is also subdivided by two secondary concave areas, one about 7 inches (18 cm.), the other about 10 inches (25 cm.), in diameter. These are again subdivided by broad, shallow pits from 2 to 4 inches in diameter. The perimetral edge formed by the meeting of the sides and base is irregular in contour and from 1 to 2 inches in thickness. The broad, shallow pits of the base, which by their form characterize this as the rear side of the meteorite, are, as has been stated, from 2 to 4 inches (5 to 10 cm.) in diameter. Their form is approximately circular, although they at times tend to be oval or polygonal. The ridges between the pits are low, rounded, and merge into the pits. The pits of the convex surface of the meteorite present considerable contrast to these. They are smaller, rarely exceeding 2 inches (5 cm.) in diameter, are deeper in proportion to their diameters, more irregular in shape, and the ridges between them are higher. They lack uniformity of shape or arrangement. Some are long and narrow, others three-sided, others again more nearly circular. The apex of the cone appears to have been less oxidized than the rest of the mass, indicating that the crust had sprayed off at this point. It presents a smooth surface about 2 inches (5 cm.) in diameter, convex except for a small, saucerlike depression about 0.5 inch (1 cm.) in diameter in its center. The base and the sides of the cone meet in a sloping edge, except on the side already described as approximately straight. Here a broad, flat surface is presented, perpendicular to the base of the cone, or as if a section had been cut through the cone at one side of the apex and removed. The pittings of this surface resemble furrows, and run, in general, parallel to the axis of the cone. Some, however, converge from points on the side toward the central point of the base. This is the course which currents of air, rushing from the front side backward to the partial vacuum behind, might be expected to take. The characters above described make it clear that the convex surface with its deeper, smaller pits was the front side of the meteorite in falling. The characters of the crust can not be determined from the cast, nor are minute drift phenomena, if any occur, to be seen. Brezina, however, states that the rear side has a bark crust 0.5 to 1 mm. thick. The plate accompanying the present paper shows the characters above described. The adoption by the writer for this meteorite of the name Iron Creek, instead of the more usual one of Victoria, is on account of information received from Mr. Johnston, of the Geological Survey, that the small mission station of Victoria, from which the meteorite received that name, is 150 miles from the locality where the meteorite was found, and it is no longer known by that name, its present name being Papan. Iron Creek is a well-defined stream only 25 miles in length, which takes its name from the fact that the meteorite was found near it. Iron Creek, moreover, is the English translation of the Indian name given to the stream before the white man entered the country. The meteorite was known to the Indians and held in great veneration by them.

The meteorite is preserved almost entire in the Victoria College at Toronto.

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Ironhannock Creek. See Tomhannock Creek.

Irwin meteorite. See Tucson.

Irwin-Ainsa meteorite. See Tucson.

IVANPAH.

San Bernardino County, California.
Latitude 35° 28′ N., longitude 115° 31′ W.
Iron. Medium octahedrite (Om), of Brezina.
Found and described, 1880.
Weight, 58.3 kgs. (128 lbs.)

This meteorite was mainly described by Shepard [1] as follows:

The locality of this find is situated in a region known as the Colorado Basin, within 8 miles of Ivanpah, 200 miles northeast of San Bernardino, in southern California. The mass was discovered in 1880 by Mr. Stephen Goddard, while crossing what is there called a "wash."

It is oval in shape, having one side somewhat flattened. Its surface is entirely covered with depressions or dents, "as if it had been patted all over with pebbles" or clam shells, while yet soft or plastic. The size and shape of these concavities are various, from 1 to 4 inches across; and in addition, there are three rounded holes an inch deep as if made by the little finger.

It measures 14 by 9 by 7 inches, and weighs 120 pounds. The iron shows a highly crystalline and homogeneous structure, requiring no etching to bring out the Widmannstätten figures; indeed, it seems probable that the crystalline structure of the entire mass is in conformity with that of a single individual. The cleavages are octahedral, and reveal a rather coarse lamination. The schreibersite separating these thick laminæ is very thin, and runs in perfectly straight lines, dividing the polished surfaces off into rather broad, triangular, and oblique-angled spaces, whose areas again are beautifully covered by very small irregular dots and characters, themselves distributed in parallel rows, but among which continuous straight lines appear to be wanting, the boundaries of the larger, triangular, and quadrangular spaces only consisting of rectilinear lines. There would therefore seem to be two varieties of schreibersite present; one in flat leaves, the other in wavy semicylinders or prisms. The latter may be the rhabdite of Reichenbach. Both kinds, however, are equally taken into solution by long digestion in aqua regia.

Analysis:

Fe	Ni	P	Graphite	
94.98	4.52	0.07	0.10	=99.67

No sulphur was present, and no examination for metals, often present in small quantities in meteoric irons, was made.

In Mineral Resources of the United States [3] for 1883–84 the following analysis of the mass by Gustave Gehring is given:

Fe	Ni	Co	Si	S	P	C (in combination)	Graphite	
94.456	4.869	0.261	0.041	0.004	0.002	0.115	0.067	=99.816

Hardness, 3.75; specific gravity, 8.076.

Analysis of the meteorite was made by O. Köstler and described by Cohen and Weinschenk,[3] as follows:

Turnings of the iron from the Vienna Museum specimen to the amount of 67.29 gr. were dissolved in HCl + 10 sq. Solution was easy and without marked evolution of H_2S. The result was as follows:

Nickel-iron in solution	66.2400 gr.	98.44
Magnetic residue, impure tænite	0.7205 "	1.07
Nonmagnetic residue	0.3295 "	0.49
	67.2900 "	100.10

The magnetic residue was not a pure product. The absence of a marked quantity of schreibersite may be due to the fact that being brittle it fell out in the turning. The nonmagnetic carbonaceous residue left behind, after heating and treatment with HCl, some small, colorless, doubly refracting grains and spheroidal particles resembling cliftonite. This may account for Shepard's graphite. Analysis by O. Köstler of a dilute solution gave:

Fe	Ni	Co	P	
91.12	6.92	1.73	0.00	=99.77

Later, Cohen [4] reported an analysis by Manteuffel, as follows:

I allowed Manteuffel to make a new analysis of Ivanpah, as the earlier one by Köstler seemed too high in cobalt. Manteuffel's analysis (substance taken, 0.7886 gr.) gave:

Fe	Ni	Co	P	Cu	
92.68	7.43	0.66	0.03	0.01	=100.81

This new analysis may be considered correct. If one takes for the isolated tænite (1.07 per cent) a content of Ni + Co of 36.96 per cent, the following composition is indicated:

Fe	Ni	Co	Cu	P	Nonmagnetic residue	
91.18	7.63	0.66	0.01	0.03	0.49	=100

The content of schreibersite can not be determined from the phosphorus on account of the fact, previously mentioned, that filings were used for the analysis.

Brezina [5] gave the following account of the structure of the iron:

Lamellæ long, straight, distinctly grouped, slightly puffy; bands, 0.5 to 0.7 mm. wide partly. Kamacite slightly flecked, granulated, with faintly oriented sheen. Tænite fine but abundant. Fields very abundant, almost entirely

filled with combs, comb heads, or bands, similar to kamacite in appearance. Dark fields free from combs seldom occur. Troilite concretions occur with or without daubréelite bands.

The meteorite is preserved almost entire in the Museum of the State Mining Bureau of California.

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Ixtlahuaca. See Toluca.

JACKSON COUNTY.

Tennessee.
Latitude 36° 25′ N.; longitude 85° 40′ W.
Iron. Medium octahedrite (Om), of Brezina.
Described 1846.
Known existing weight 209 grams (15 ozs.).

Troost [1] described this iron in 1846 from a piece weighing about 15 ounces, received from S. Morgan and found in Jackson County, Tennessee. Any further details regarding the history, size, and place of discovery of the iron are unknown. The finder supposed it to be silver, and accordingly kept the place of find secret,.

Troost states that his piece was an accumulation of large crystals, some of an octahedral, others of a tetrahedral form, of a very soft, malleable iron. The piece was accompanied by crust fragments weighing $3\frac{1}{8}$ ounces. This was a hydroxide of iron of brown and yellow color, penetrated occasionally with metallic iron and resembled, he states, the crust of the Sevier County iron. The iron itself, however, he states, differs from the latter.

Brezina [2] states that the iron is a medium octahedrite, but that the small quantity in possession of the Vienna collection prevented further study. Wülfing,[3] probably on account of Troost's mention of the similarity in crust, inquires whether this should be united with Cosby's Creek (Troost's Sevier County), but the classifications differ and the localities are widely separated.

The small quantity known is distributed.

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Jalisco. See Tomatlan.

Jamaica. See Lucky Hill.

JAMESTOWN.

Stustman County, North Dakota.
Latitude 46° 56′ N., longitude 98° 40′ W.
Iron. Fine octahedrite (Of) of Brezina.
Found 1885; described 1890.
Weight, 4 kgs. (9 lbs.).

This meteorite was first described by Huntington [1] as follows:

This meteoric iron was found in November or December, 1885, during the construction of the James River Valley branch of the Northern Pacific Railroad, about 15 or 20 miles southeast of Jamestown, Stutsman County, North Dakota.

It was found by one of the workmen, who gave it to Mr. John W. Gilbert, conductor of the construction train, explaining that he had taken it out of a slanting hole within 5 feet of the track. It is now impossible to find the exact locality, since the road was laid through new country, away from wagon roads or trails, and no particular attention was paid to the matter at the time.

The specimen weighs 4,015 grams, and is of peculiar shape and appearance. Most of the meteoric irons which have been collected and recorded appear to be angular fragments of larger original masses; but this one appears like a thick scale or splinter, which must have been blown off from the spherical surface of a large body, since the entire specimen is curved. Through the center runs quite a thick zone which gradually narrows down to sharp ridges on all sides, these edges forming a continuous curved outline, with no jagged points or projections. It measures 26 cm. long, 13 to 3.7 cm. wide, and 1.8 cm. thick. The exterior shows two utterly different surfaces; the convex side, which must have formed the crust of the original mass, appears quite smooth except for a succession of small pittings, with a little drop of chloride of iron in the center of each, making it rust rapidly, thus causing little scales to flake off and thereby possibly producing the depressions. On the other hand, the concave side is characterized by a vesicular structure not unlike certain furnace specimens, some of the cavities being 2 cm. across and nearly as deep. These cavities seem to be distributed with more or less regularity in three parallel zones across the shorter dimensions of the surface. These cavities appear to have no connection with the pittings of the surface. They seem to suggest an evolution of gas from the material in the process of cooling, which may have been the cause of the splitting off of the specimen from the original mass.

Even the most malleable meteoric irons usually exhibit very striking peculiarities of cleavage parallel to certain crystalline faces, large cleavage crystals being broken out from even such very compact irons as Bates County and Coahuila. Indeed, the cleavage is sometimes relied upon as a means of distinguishing different meteoric irons when other methods fail. But the fracture of this specimen exhibits no sign of cleavage. In fact the iron is so malleable as to be readily rolled out into thin ribbons in the cold. Such extreme malleability and the peculiar fracture separate this iron from all others.

However, etching of the polished surface produces typical Widmannstätten figures, but showing plates not over 1 mm. thick, closely interlaced, frequently bent, and occasionally intersected by linear inclusions of troilite 2 or 3 cm. long. The figures closely resemble those of Oldham County, and are not unlike those of Obernkirchen, by being so closely interlaced as to appear somewhat confused until carefully examined. On first etching the iron there was a blackening of the surface, as in the case of steel, which gives, for the moment, prominence to the figures; the superficial deposit is easily rubbed off, when the surface appears bright and shining but the figures indistinct.

A preliminary analysis gave:

Fe	Ni	P	Cu	
90.24	9.75	0.05	Trace.	=100.04

Brezina [2] described the Vienna section as follows:

This iron is noteworthy on account of its extreme softness, as well as for the zone of alteration surrounding the entire mass, which extends some 12 mm. deep on the wedge-shaped border, while it is 3 mm. broad on the convex front side and completely disappears on the nearly level rear side. The lamellæ are 0.2 mm. in width, bands bent and bunched; kamacite very finely hatched; fields few and small and of a dark-gray color.

Cohen [3] described the structure as follows:

The fragment described by Brezina appears to have come from the thicker portion of the meteorite; a few sections which I had occasion to investigate more accurately and which were apparently portions of the sharp edge were different in character.

The slightly bunched, nongranular bands were of very uneven length and of conspicuously irregular form; the tænite ribbons were fine, but, especially after strong etching, distinctly prominent; the fields uniformly small and subordinated to the bands. The extremely dull luster of the etching surface and the resemblance of the bands and fields are very characteristic of this specimen; now the one and now the other appears the darker of these two, according to the lighting. Even under the microscope both appear to be fine grained and are often only in a suitable light distinguished from one another by the tænite seams; occasionally they are distinguished by the appearance in a few fields of glistening flakes about 0.01 mm. in size. Under stronger magnification it becomes apparent that very small fields, filled with compact, dark plessite, are present in considerable numbers.

On the whole, it appears that the specimen which I examined belonged entirely to the alteration zone.

Minor constituents are very scarce in these examples also. I did not find any schreibersite, and troilite only in small crystals, 4 mm. long and 0.5 to 1 mm. thick, which are abruptly truncated at one end by a face and pointed at the other, in consequence of which they appear hemimorphous, and very much resemble those previously described from the Cape iron. Sometimes the crystals are insterected with daubréelite plates.

The meteorite is distributed, the British Museum possessing 1,627 grams; Harvard, 1,570 grams.

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JENNIES CREEK.

Wayne County, West Virginia.
Here also Charleston, Kanawha County, and Old Fork.
Latitude 38° 20′ N., longitude 82° 22′ W.
Iron. Coarse octahedrite (Og), of Brezina.
Found 1883; described 1885.
Weight: Three masses of 23 pounds, 2 to 3 pounds, and 535 grams, respectively. Known existing weight, 1,100 grams (2.4 lbs.).

This meteorite was almost wholly described by Kunz,[1] as follows:

During the early part of April, a 9-ounce piece of mineral, supposed to be silver, was sent to Dr. H. G. Torrey for determination by Maj. Delafield Du Bois, of Charleston, West Virginia. Dr. Torrey found it on examination to be an iron of meteoric origin, and kindly loaned it to me for description. The piece delivered to me was supposed to be all of the fall, and on this supposition it was described as the Charleston, Kanawha County, West Virginia, meteorite, in a paper read at the Ann Arbor meeting of the American Association. Through the kindness of Maj. Du Bois, Mr. J. F. Hoard and Dr. John N. Tilden, who went to considerable trouble in ascertaining it, I am able to announce the true locality.

Mr. Hoard writes that the iron was found on land belonging to Maston Christian, situated on the "Old Fork" of Jennys Creek, a tributary of the "Tug Fork" of Big Sandy River (Tug Fork being the boundary line between West Virginia and Kentucky), in the upper end of Wayne County. The pieces were all found in the creek bed, i. e., the ravine or gulch through which the creek flows. The first piece, weighing probably 2 or 3 pounds, was found by Christian's wife sometime earlier than the spring of 1883. It was supposed to be simply a rich "kidney" of limonite, and was soon lost sight of. In the spring of 1883, however, a second piece was found by Christian himself while drifting staves in the creek. This piece, which weighed about 23 pounds, created considerable excitement and speculation. It is even stated that a shrewd speculator, who had in his possession a lump of the metal, had realized largely by burying it on different lands, digging it up again, and then selling the pieces of property successively as being silver bearing. The rumor was current that the vein was from 9 to 16 inches thick. It was broken up and distributed among several parties interested in the find, and as it was friable, much of it was lost in this manner. About the first of December, 1885, a third fragment was picked up by Mr. Christian in a pool of still water, only 15 or 20 feet from where he found the other. It weighs 535 grams (about 17 ounces), is all broken except one side which is altered to limonite, and has no visible trace of unaltered crust. Its measurements are 88 mm., 57 mm., and 46 mm. The total amount found thus far in the three pieces is probably 26 or 27 pounds. Both of these latter pieces were found in water and had a coating of rust or earthy matter similar to that found on "kidneys" of ore, which was removed easily with the hands or by washing.

The iron is octahedral and made up of crystalline blocks of plessite and kamacite, irregular in shape, brittle, having rounded ends and cleaving readily. Between these are also thin, springy, and flexible folia or plates of schreibersite, some of which are 6 or 8 mm. square. The latter mineral was also observed in two other small pieces sent to me. Troilite was also observed in these. The original weight of the piece loaned me for description was 275 grams; one small slice of 34.5 grams weight had been removed to show the internal structure, so that the larger piece now weighs 228.2 grams. Three cuts show the exact size of these pieces, and the markings on the etched surface as well as the octahedral structure on the exterior of the iron have been accurately reproduced by photography direct from the iron. (Original size as follows: length, 66 mm.; width, 40.5 mm.; height, 33.5 mm.) The exact date of the fall of this iron is not known, and the surface where not cracked off is altered to limonite to a depth of 2 mm. It belongs to the "grobe Lamellen" of the new classification of Dr. A. Brezina. The Sevier County, Tennessee, and the Arva irons nearest approach it in structure. The following analysis was kindly made by Mr. J. B. Mackintosh, E. M., of the School of Mines, New York.

Iron	91.56
Phosphorus	0.13
Nickel and cobalt (by difference)	8.31
	100.00

The specific gravity of the figured mass is 7.344. The iron does not show any Widmannstätten figures, the crystalline structure being really brought out in relief by the schreibersite between the crystalline surfaces of the iron.

Since this iron was broken and scattered in small pieces, we may expect to see them turn up as a number of different falls, but the coarsely crystalline structure, and the broken appearance of the pieces which are characteristic of this fall, will at once identify them.

The late Judge M. J. Ferguson, while residing at Louisa, Kentucky, communicated to Mr. S. Floyd Hoard that one summer about 5 years ago, at about 1 a. m., he witnessed a meteor of wonderful brilliancy falling in the direction of the spot where these fragments have since been found; and that he predicted at the time that one would probably be found in that vicinity. The windows facing that way were open, and the curtains drawn back. The light was as brilliant as noonday, and of sufficient duration for him to step to the window and see the meteorite fall, as he thought, a short distance away, and surely within the limits of Wayne County.

There is, therefore, a strong probability that the pieces now being described are fragments of the identical meteorite which startled Judge Ferguson on that night. The fact that these masses of meteoric iron were found in water, and that all the branches of the creeks in this county are subject to strong floods of a few hours' duration, but while they last, sufficient to float logs, may account for the finding of these three pieces (evidently fragments of one piece of of very friable iron), scattered as they were, and also for the oxidation of the crust of the iron, which might have remained intact for a much longer period, had the meteorite buried itself in the earth. Of the 26 or 27 pounds which were found, only about 2 pounds have been preserved. I am under obligations to Maj. Delafield Du Bois, S. Floyd Hoard, and Dr. John N. Tilden, for obtaining information and material.

Huntington [2] expressed the opinion that this meteorite belonged to the Cosby Creek, Cocke County, fall. Kunz [3] accepted this suggestion. The opinion has not been followed by later cataloguers, however, and there seems little reason for it.

Brezina [5] has the following mention of the iron:

Old Fork (of Jennys Creek) is an iron made very porous by weathering, and one which sometimes falls to pieces in a sort of rubble of from 3 to 10 mm. in bulk. The structure has great similarity with that of Cosby Creek.

The small quantity of the meteorite known is distributed, Vienna having the largest amount, 587 grams.

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JEROME.

Gove County, Kansas.
Latitude 38° 47′ N., longitude 100° 14′ W.
Stone. Spherulitic crystalline chondrite (Cck), of Brezina.
Found 1894: described 1898.
Weight, 29.6 kgs. (65.25 lbs.).

This meteorite was described chiefly by Washington,[2] as follows:

The meteorite, described in the present paper, was acquired for the Yale University Collection about a year ago, through the generosity of members of the class of 1857. Professor Dana entrusted it to me for examination, for which kindness I desire to express my hearty thanks.

Little is known of the circumstances of its finding, and all that could be ascertained was published by Professor Dana in a note in the Yale Alumni Weekly for May 6, 1897, from which I quote the following:

"It was found April 10, 1894, by Mr. H. T. Martin, on the Smoky Hill River, Gove County, Kansas, about 15 miles east of Jerome. Mr. Martin was then engaged in hunting fossils, and his attention was attracted by this mass, whose appearance was quite foreign to the rock of the neighborhood. It proved on examination to be a meteorite, of the circumstances of whose fall nothing has been learned. The same State has furnished a number of other meteorites at points considerably distant from that where the present one was discovered, and it is possible that some of them may prove to have been parts of the same original meteor. The stone has been placed in the center of the case devoted to meteorites in the mineral room of the Peabody Museum."

As the Smoky Hill River is several hundred miles long, and other meteorites may be found in the extended area of Gove County, I propose for this mass the name of the Jerome Meteorite, after the nearest town.

The stone consists of several pieces, the largest weighing about 62 pounds (30 kg.), with several smaller fragments, the largest of which weighs 2.5 pounds and collectively 3.25. One of these was apparently broken off at the time of fall, as none of its surfaces are those of a fresh fracture.

The main mass measures some 12 inches in its largest diameter, the other dimensions being between 9 and 10 inches; it has roughly pointed ends, and its polyhedral form is vaguely suggestive of a dodecahedron drawn out in the direction of its vertical axis. One end is quite sharply pointed, while the other is blunter and irregular, showing some fresh and other older fracture surfaces, and is apparently the point of impact. From this broken surface a number of fine cracks radiate through the body of the mass.

The mass is bounded by fairly plane surfaces, some being quite flat, while others are more or less warped. The angles are rounded. A few shallow pits are seen, and here and there ovoidal nodules, which project slightly above the main surface, or from the bottoms of shallow depressions. These measure several centimeters in length, with a width of about two-thirds of the length.

A thin, dark brown crust covers the surface, but this has suffered through atmospheric decomposition, and is much corroded, lacking in places, and often dull and rusty. No signs of ridges or other flow phenomena are to be seen on

what is left of the crust. Small, rough, wart-like processes are seen generally over the surface, some due apparently to the projection of chondrules through weathering, while others are the less altered fragments of crust.

Parts of the meteorite, especially near the point of impact, and the fragment (0.75 pound) which shows no fresh fracture surfaces, are covered with a fine, yellowish white powdery substance, which effervesces but slightly in acid, and is apparently a light clayish soil. The same substance is found in the cracks previously mentioned.

The fresh fracture is uneven, and the stone, as thus seen, is fine-grained and compact. The general color is dark rusty brown, which under the lens is seen to be a mottled brown and black. Small, glistening streaks of nickel iron are scattered through it, but no troilite was seen. The lens also reveals translucent grains of olivine and bronzite. Small rounded chondrules are also seen here and there, but are not very numerous.

It is very evident that the oxidation of the iron from weathering extends far into the mass, though possibly a section through its center might reveal fresh substance. Of the stones in the Yale collection it resembles most that from Salt Lake City, and is also much like the decomposed portions of the Bluff, Fayette County, Texas, meteorite.

Under the microscope the stone is seen to be composed of quite numerous chondrules of bronzite and olivine, with fragmental crystals of olivine, bronzite, and a little pyroxene, in a rather brecciated groundmass of the same minerals, together with some interstitial matter, which seems to be glass. Nickel iron is present in the form of small, angular, irregular masses. Patches and veins of dark, reddish-brown, and yellow ferruginous substance are present, and show that considerable atmospheric decomposition has taken place. A few small fragments of plagioclase are also to be seen, but no troilite, and nothing which could be referred with certainty to maskelynite.

On the whole, I am inclined to class this stone with Brezina's group 37, "krystallinisch Chondrit, breccienähnlich (ckb),"[1] though I have no sections of either of his two examples for comparison. It will be remembered that it resembles megascopically the less fresh parts of one of these, the Bluff meteorite.

The chondrules of bronzite run up to nearly 2 mm. in diameter, and show, in most cases, circular sections, or nearly so, though angular and fragmental forms are seen. They present the usual fibrous, eccentrically radiated structure.

The olivine chondrules are somewhat larger, up to 3 mm., and show greater variety. Many are monosomatic, with parallel plate structure and border as figured by Tschermak. The interstitial matter here is granular, colorless, and isotropic, containing small, black, opaque particles. It is possibly a glass, as in the cases described by Tschermak, though its pronounced granular character is against this view, and points rather to the idea that it is maskelynite. These chondrules are usually small and round.

Porphyritic olivine chondrules are more numerous, as well as the largest in size, and are occasionally rounded, but usually irregular in outline. They consist of oblong grains and crystals (showing traces of pinacoids and domes) of colorless olivine, lying pell-mell in a gray or colorless, finely fibrous groundmass. This is formed of patches of straight, narrow fibers parallel over small areas, each small area extinguishing as a unit, but unlike those adjacent, where the fibers run in another direction. It was supposed at first that these thin, colorless rods were a rather basic plagioclase, since they extinguish at various angles up to 20° with their long axes, and their polarization colors are grays and pale yellows. Close examination under high powers, however, revealed the fact that in many places there is no break in continuity between the fibers and distinct adjacent olivine crystals, and that in these cases both crystal and fibers extinguish simultaneously. They must, therefore, be referred to olivine, and the apparent oblique extinction is due to the fact that the fibers project obliquely from the surface of the olivine crystal, seemingly in the direction of a domal or prismatic plane. That they are rods and not plates (as in the preceding type of chondrules) is shown by their sections in certain places, where they present the appearance of small rounded grains. Such skeletal development is a not uncommon feature of olivine, as is well known.

Other porphyritic chondrules are seen in which olivine crystals and fragments are embedded in a fine-grained mosaic of olivine and enstatite grains. One peculiar ovoidal chondrule was observed, composed of a long, seemingly corroded, olivine crystal, surrounded by a mosaic of small grains of the same mineral. There were a few monosomatic chondrules of olivine, with approximately circular outline, but curiously and irregularly hollow, the interstices between the separate patches of olivine being filled with granular bronzite. Others again were found with monosomatic borders and portions of the interior of bronzite, containing olivine grains.

The crystals and fragments of bronzite and olivine offer no features of special interest. They are colorless, except where stained by ferruginous decomposition products, and are quite fresh, even the olivine showing no traces of serpentinization. Each mutually incloses the other, so that they were apparently crystallized at the same period. Both include small angular fragments of iron. Only a few crystals and fragments which could be definitely referred to pyroxene were observed. In one case two pyroxene fragments, giving oblique extinction, are inclosed in a patch of bronzite. A few grains which may be referred to plagioclase were found, one of these showing traces of twinning lamellæ.

Grains of nickel iron are quite abundant. They are all small and angular and irregular in outline, and apparently generally later than either the olivine or bronzite, as they are xenomorphic toward these and occupy the interstices between them, and also include crystals and fragments of these minerals. At the same time, as we have seen, small particles of iron are included in these minerals.

The iron has suffered greatly from oxidation, being usually surrounded by yellow, or deep reddish-brown, translucent, doubly refracting matter. This is probably limonite, since it answers to Pelikan's description of limonite under the microscope, and since the analysis shows that there is no silica, above that necessary for the olivine, etc., to form a ferrous silicate, as it was suggested to be by Kunz and Weinschenk in the case of the Washington, Kansas,

meteorite. This ferruginous substance has penetrated all the crevices of the mass, being found in the interior of even the largest mineral grains, is seen in patches throughout all the sections, and is what gives the brown color to the mass.

A careful search revealed no grains of troilite, though the chemical analysis shows that about 5 per cent was probably present originally. It has possibly been entirely decomposed.

For the chemical analysis 25.2 grams were taken, of as fresh material as was available, with no crust attached. An attempt was first made on 13 grams to separate the nickel-iron by means of an electromagnet. This proved to be a matter of great difficulty, on account of the very dense and compact texture, and after two days had been spent in successive separations under alcohol, and after analyses of the products had been partially completed, this method was abandoned.

Eggertz's iodine method was finally employed and proved fairly satisfactory.

The results of the several analyses are given below, the total analysis being calculated from the data furnished by the others. Part of the Cr_2O_3 was determined as chromite—this being assumed to have the simple composition $FeCr_2O_4$; the rest was precipitated as $PbCrO_4$. H_2O was determined as such in the total meteorite by Penfield's method, and referred to the soluble portion. S and P_2O_5 were likewise determined in the total meteorite. The separation of soluble and insoluble silicates was effected in the residue from the solution of the nickel iron by digestion on the water bath for three hours with dilute HCl (1 : 5), and subsequent treatment with dilute KHO solution. The extra oxygen of the soluble portion, the total iron being determined as FeO, is that belonging to the ferric oxide of the limonite. It was estimated by calculating the amounts of olivine, augite, and diopside present, and deducting the amount of FeO belonging to them from the total FeO.

The specific gravity was found to be 3.466 at 15.5° C., taken with the balance, on a mass of 11 grams. The first approximate composition is:

	Nickel iron	4.25
Soluble	Troilite	5.16
	Silicates	54.47
Insoluble	Chromite	0.87
	Silicates	35.25
		100.00

The analysis of the nickel iron yielded:

Fe	89.67
Ni	10.01
Co	0.32
Cu	undt.
	100.00

The analyses of the soluble and insoluble portions, together with the calculated total composition, are as follows:

	Soluble in HCl.	Insoluble in HCl.	Total.
SiO_2	21.34	56.44	33.11
TiO^2	.....	small amount	small amount
Cr_2O_3	.....	1.61	0.58
Al_2O_3	0.27	4.85	1.77
FeO	41.38	9.16	27.97
Fe	.....	.....	3.81
NiO	2.67	trace	1.77
Ni	.....	.....	0.43
CoO	trace	.....	trace
Co	.....	.....	0.01
MnO	.....	trace	trace
MgO	22.86	22.03	21.59
CaO	0.46	2.87	1.31
Na_2O	undt.	1.79	0.65
K_2O	undt.	0.77	0.28
H_2O	5.08	.....	3.03
P_2O_5	0.62	.....	0.37
S	3.15	.....	1.88
Extra O	2.88	.....	1.76
	100.71	99.52	100.32
Less O=S	1.57		0.92
	99.14		99.40

It is evident that the soluble portion is made up largely of olivine, with troilite and limonite, and small quantities of pyroxene and oxide of nickel; while the insoluble is chiefly bronzite, with accessory chromite, feldspar, and augite.

Calculation from the data furnished by the analyses shows that the mineralogical composition of the stone is approximately:

Nickel iron	4.3
Troilite	5.2
Chromite	0.9
Schreibersite?	0.8
Olivine	30.2
Bronzite	23.6
Pyroxene	5.0
Oligoclase (Ab_5An_1)	6.6
Orthoclase	1.6
Limonite	20.2
Nickel oxide	1.6
	100.0

In the above, all the phosphorus is assumed to exist as schreibersite, soda and potash to belong to the feldspars, and the NiO to be the product of the oxidation of the nickel iron. It will be evident that if, as seems certain from the microscopic examination, the limonite is derived entirely from the metallic iron, the amount of metallic Fe originally present was higher by some 12 per cent, and the nickel higher by 1.25 per cent. The nickel iron present in the fresh stone would then have amounted to about 17.50. That the orthorhombic pyroxene is bronzite rather than enstatite is shown by its calculated composition, which is—

SiO_2	56.8
MgO	32.6
FeO	10.6
	100.0

The pyroxene is largely diopside, with less than 10 per cent of the aluminous augite molecule. The plagioclase is an oligoclase of the composition Ab_5An_1. The orthoclase molecule probably also belongs with it, in which case it must have about the composition $Ab_5Or_1An_1$.

On the whole the stone seems to belong to a rather widespread group, and does not differ essentially from several that have been recently described from this continent, e. g., the Salt Lake City, the Bluff, the Beaver Creek, and the Washington, Kansas, meteorites.

Preston [3] suggested that this stone might belong to the same fall as Long Island and Prairie Dog Creek, but Farrington [4] concluded from a study of the structure that it was probably a distinct fall. Berwerth [5] included Jerome under Prairie Dog Creek. Brezina [6] classed the meteorite as a sphérulitic crystalline chondrite.

The meteorite is chiefly preserved in the Yale University collection.

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JEWELL HILL.

Madison County, North Carolina.
Here also Jewel Hill.
Latitude 35° 32′ N., longitude 82° 28′ W.
Iron. Fine octahedrite (Of), of Brezina; Jewellite (type 9), of Meunier.
Found 1854 and 1856; described 1876.
Weight, two masses of 18 and 3¾ kgs. (40 and 7 lbs.).

The history and characters of this meteorite have been summarized by Cohen [14] as follows:

According to Venable,[10] the county seat of Madison County was formerly called "Jewell Hill"; and the name was later changed to Duel Hill. Three masses were said to have been found there, two of which were described briefly; namely, a mass weighing 3¾ kg., found in 1854 and described by Smith,[1] and a block of 18 kg. weight found in 1856 of which 787 grains found their way into the Amherst College collection. Burton, however, described in 1876

a 11.5 kg. iron from Duel Hill found in 1873, and mentions the fact that about 1857 a mass weighing 18 kg. was discovered at a distance of 1.5 km., which, however, was lost. Genth and Kerr [7] observe that the piece described by Smith (3¾ kg.) may possibly have come from the 18 kg. block which was apparently lost. According to Professor Emerson, and from a photograph furnished by him, there are in the Amherst collection two specimens of 167.5 and 1,134 gr. which both belong to the octahedrites with fine lamellæ. As there are now more than 3¾ kg. from Jewell Hill in collections, Burton's statement that one of the masses was lost seems to be an error. We must conclude, therefore, that specimens from three masses are represented in collections, two of which (3¾ kg. and 18 kg.) belong to an octahedrite with fine lamellæ and the third (11½ kg.) shows coarse lamellæ. All three were found in the same locality (formerly Jewell Hill, now Duel Hill). So long as no more definite information as to the place of discovery is to be had, and it is not proved that one fall can yield two masses of such entirely different structure, it seems most appropriate in order not to cause a new confusion, to retain both names; that is, to call the fine octahedrite Jewell Hill, the coarse octahedrite Duel Hill.

According to Smith,[1] the mass here indicated as Jewell Hill weighed 3¾ kg., showed a few pittings upon the surface and was covered with a thick coat of rust which continually exuded drops of iron chloride. Its analysis is given below under I.

Reichenbach [2] mentioned bronze-colored iron sulphide; Rose,[3] very fine Widmannstätten figures.

Meunier [4] gave Jewell Hill as a typical example of plessite which is here mingled only with tænite. Later,[11] he classed it together with La Grange and Bückeberg in a group, "Jewellite" (composed of like parts of tænite and plessite); the very fine tænite lamellæ of which intersect each other quite irregularly, are dull in the interior, shining at the edges, and frequently form very characteristic combs. Schreibersite occurs in small particles; troilite is wanting.

Tschermak [5] first observed the Reichenbach lamellæ, which here attain a thickness of only 0.15 mm. He compared them with those of Ilimaë and noted in the case of both irons that the lines were oriented parallel to the planes of a cube.

Jewell Hill is distinguished from Tazewell, according to Sorby, in that it consists of three elements, one of which may be schreibersite (tænite); both irons agree in original structure.

The bands measure 0.17 mm. in width, are long and straight, and frequently have a finely jagged border. They are very little swollen, seldom and then only weakly grouped, and entirely free from granulation. The tænite bands are unusually broad, the fields not very large, but regular and prominent. The kamacite is throughout spotted-striped and occasionally shows also line systems which look like file scratches. If it is actually so, each band must be an individual, and one can not even by the highest possible magnifying power detect anything that would indicate a formation composed of grains; the flakes are in no way defined, but there appears now a fine flaming and now a finely netted structure, as if there were tiny inclusions present. With stronger etching the kamacite becomes duller and approximates the appearance of the plessite. A small portion of the fields consists of dense, almost black plessite; under the microscope, however, it is shown nevertheless that they contain tiny glistening scales evenly distributed. The larger portion of the fields is considerably brighter and, even under the magnifying glass, is shimmering, this being occasioned by the fact that the highly glazed and here regularly distributed inclusions are larger and more numerous than usual. They consist principally of bands 0.003 mm. in thickness, in the form of rods, hooks, or crooked fragments, and a brighter or darker groundmass having the appearance of compact plessite. The structure, viewed under a magnifying power of 220 diameters, resembles the micropegmatitic intergrowth of feldspar and quartz which I have more fully described in connection with the Smiths Mountain meteorite, where the inclusions are not so fine as here. Besides this, there often occur in considerable number glistening disks as much as 0.025 mm. in size, which appear to be older than the micropegmatitic-like groundmass. These areas are occasionally intersected wholly or partially by small, complete lamellæ, which are branches of the principal lamellæ of such a sort that the tænite seams run together but not the bands. The quite regular distribution of the lamellæ, which are seldom and then only slightly grouped, as well as the predominance of the fields and the prominence of the tænite, cause the figures to be of the most beautiful and regular varieties afforded by octahedral irons.

Reichenbach lamellæ are present in large numbers, as many as 30 having been counted on a section of about 20 sq. cm. They are almost always connected and are distinguished by extreme fineness. In the plate examined by me they appeared, under 200 diameters enlargement, as mere threads, whose thickness scarcely exceeds 0.01 mm. Tschermak [5] and Brezina [13] give much larger dimensions. The swathing kamacite has an uneven border; it sometimes attains the width of the bands, while in other places it is so constricted as to be discerned only under the microscope. The small and somewhat abundant schreibersite grains lie exclusively in the bands and in the swathing kamacite. According to Brezina,[13] the kamacite in the 2.5 mm. alteration zone is considerably more finely flaked than in the interior of the iron.

Analysis by Smith (I); by Bürger (II):

	Fe	Ni	Co	Cu	Cr	P	S	Residue	
I.....	91.12	7.82	0.43	trace	.....	0.08	....	.....	=99.45
II.....	88.78	9.90	0.81	0.02	trace	0.13	0.13	trace	=99.67

Jewell Hill takes on fairly strong permanent magnetism; the specific magnetism was determined by Leick as 2.35 absolute units per gram.

The meteorite is distributed, but having been much confused with Duel Hill it is impossible to determine from catalogues how much of Jewell Hill is actually in collections. Wülfing unites the two.

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JOE WRIGHT MOUNTAIN.

Independence County, Arkansas.
Here also Batesville, Elmo, and Independence County.
Latitude 35° 49′ N., longitude 91° 37′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1884; described 1886.
Weight, 42.5 kgs. (94 lbs).

This meteorite was described by Hidden[1] as follows:

This meteor was found about the last of June, 1884, by George W. Price, on what is known as the Joe Wright Mountain, a small eminence about 7 miles east of Batesville, Independence County, Arkansas. The soil there was cut into deep gullies, which farther down the mountain side converged into one, at which point this meteorite was found. * * *

The weight of the mass was 94 pounds. It was 17 inches long and 8 inches thick. Its surface was pitted with ovoid depressions of various sizes, lying with their longer axes in nearly the same general direction.

The exterior was almost black in color and looked blistered. No rust or alteration from oxidation was noticed on any part, indicating that the mass had not lain long upon the earth. * * * A large hole near the edge measured five-eighths of an inch at its smallest part, was 1.75 inches long, and was cone-shaped from both sides.

Etching showed Widmannstätten figures well developed. Troilite having a bronze color and luster occurs as thin seams and veins on the polished face and extends far into the mass. Schreibersite as rather large bright points was also noticed.

Analysis (Mackintosh):

Fe	P	Ni and Co (by difference)	
91.22	0.16	8.62	=100.00

Other elements were not looked for.

Brezina[2] remarked regarding the form of the mass as follows:

An unusual interest attaches to the iron from Joe Wright Mountain on account of its natural perforation, due to its great richness in troilite.

Joe Wright and Glorieta stand in a certain opposition, as they illustrate two very different methods of the rending of meteoric iron; the rending, in consequence of perforation, widening the holes until they form a ring, and finally bursting the ring, of which method Joe Wright shows the primary stage; and, on the other hand, the rending in consequence of the formation of fractures of which the Glorieta iron shows the final stage.

Cohen[3] gave an account of an investigation of this iron, as follows:

About 32 grams of this iron were investigated. Etched faces show hatched kamacite, distinct tænite border, and plessite of separate formation. One part contains delicate combs, another is of granular structure, and then either uniformly dark gray or rich in minute shining points. Especially characteristic are little plates above 1 mm. in thickness and up to 35 mm. in length, which seem to stand perpendicularly to one another and qualitatively appear to be schreibersite.

A mass analysis yielded:

Fe	Ni	Co	P	Residue	
91.67	7.53	0.99	trace	0.00	=100.19

Solution of 31 grams in dilute HCl gave:

Dissolved nickel-iron	95.84
Tænite	1.74
Angular pieces	0.12
Schreibersite	2.12
Rust and carbonaceous substance	0.18
	100.00

The schreibersite is normal in appearance, tin white to steel gray, cleavable with conchoidal fracture. The tænite resembles that of Glorieta Mountain in that the foliæ are mostly united in bundles and are only exceptionally interrupted by angular pieces.

Brezina's[4] description is as follows:

The bands are noticeably puffy, much grouped and crumpled; lamellæ 0.6 mm. in width; kamacite hatched, sometimes flecked; tænite well developed; fields quite numerous and large, for the most part filled with very fine ridges, often running in only one direction, which, in a diagonal cross section gives the areas a granulated appearance; only the smallest fields are empty, which then appear very dark. Schreibersite is very abundant, in large compact plates parallel to the kamacite bands of equal or greater breadth with the latter, also as granular-puffy borders around the troilite concretions. Numerous Reichenbach lamellæ 2 to 3 cm. in length occur which are conspicuously irregular in accordance with the general crumpling of the figures. These are often accompanied with quite compact schreibersite, serving as a nucleus for the lamellæ.

The meteorite is chiefly preserved in the Vienna collection.

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Kanawha. See Jennies Creek.

Kansada. See Ness County.

Johnson County. See Cabin Creek.

JONESBORO.

Washington County, Tennessee.
Latitude 36° 16′ N., longitude 82° 30′ W.
Iron. Fine octahedrite (Of), of Brezina.
Found 1891; mentioned 1892.
Weight, 30 grams (1 ounce).

Nothing seems to be known of the history of this meteorite. The first mention of it seems to have been in a price list published by Ward's Natural Science Establishment in 1892,[1] in which the locality was given and the weight 1 ounce. The whole piece seems to have been acquired by the Vienna Museum and was described by Brezina[2] as follows:

The Jonesboro iron appears, on the small specimen found in our collection, to be completely bounded by octahedral weathered surfaces; lamellæ 0.25 mm. thick, straight, with little or no bunching; kamacite abundant and hatched lengthwise; fields abundant, comparative large, filled with bright, lustrous plessite, which exhibits a very fine repetition of the band system.

Cohen[3] gave a further account of the structure of the iron as follows:

The straight, sometimes slightly bunched lamellæ are long, not puffy, and only occasionally slightly granular. The tænite borders are not very prominent. The fields are tolerably large and prominent. A characteristic of this iron is the unusual abundance of very distinct hatching running in every direction in the kamacite; many bands appear somewhat speckled apparently because of the compact bunching of tiny etching pits. The fields are not, as Brezina thought, a repetition of the band system, but are completely filled with comparatively bright, fine-grained

plessite, which is distinguished from the usual compact, dark variety only by reason of the somewhat coarse grain and greater abundance of glistening scales (or grains?). Under stronger magnification the latter stand out distinctly upon a black, dull groundmass. Brezina's error is accounted for by the fact that the glistening scales are sometimes arranged in rows. Aside from a few small schreibersite grains no minor constituents were observed.

All that is at present known of this meteorite (28 grams) is in the Vienna collection.

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KENDALL COUNTY.

Texas.
Latitude 29° 39′ N., longitude 98° 25′ W.
Iron. Granular hexahedrite, Hk. Brecciated hexahedrite (Hb), of Brezina; Kendallite (type 23), of Meunier.
Found ?; described 1887.
Weight, 20⅝ kgs. (45.9 lbs.).

The history and characters of this meteorite are given in a summary by Cohen [9] as follows:

Kendall County was first mentioned by Brezina [1] in 1887, who gave its weight at 20⅝ kg., and compared the iron provisionally to Zacatecas. In 1893, he [2] referred it to his breccialike hexahedrites, stating that the size of the individual distinctly separated grains varied from a few millimeters to 3 to 4 cm. In 1895, he [4] noted the presence of troilite grains, mostly angular and of a maximum diameter of 4 cm., which were penetrated by tongues of iron or a granular iron band. In a few grains of iron he noted peculiar skeletons produced by etching, which were taken for troilite. Small iron grains were also mentioned as occasionally surrounding a large one in the form of a wreath.

According to Meunier,[3] Kendall County is distinguished from all other irons by its fragmentary and heterogeneous structure. A few fragments give by etching, he states, regular figures, but most of them show only a sort of mohair sheen. A black, carbonaceous substance occurs, sometimes in granular particles, sometimes as a matrix of the "breccia." The specific gravity varied from 6.94 to 7.10.

In 1895, Moissan [6,7] examined Kendall County for diamond and graphite. After dissolving with dilute hydrochloric acid and treating the residue with aqua regia there remained a black, amorphous substance, mixed with numerous transparent little grains which disappeared after repeated heating with sulphuric acid and hydrofluoric acid at varying temperatures. The remainder appeared as amorphous carbon, which was with difficulty attacked by nitric acid and potassium chlorate, but left no trace of carbonic acid. A part of the transparent grains were regarded as sapphire; the other portion, of a bottle-green transparent character, was not definitely determined.

Cohen's [8] study gave the following:

After etching, the nickel iron is decomposed into grains whose diameter varies from 0.5 mm. to 3 cm.; although a measurement of 1 cm. is the exception. Moreover, different portions of the meteorite vary somewhat. In many places, the larger part of the cracks dividing the grains are filled with an intimate mixture of schreibersite with a graphitic substance, occasionally also with one of the two metals alone. A close examination showed that not graphite but amorphous carbon was present, as Moissan had already proved. By dissolving the nickel iron in dilute hydrochloric acid the above combination is left in thin plates 1 sq. cm. in size. In other places lumps of carbon-schreibersite as much as 3 cm. in size occur between the grains of nickel iron, which run into the former in the shape of small, elongated tongues. After weak etching most of the grains show only Neumann lines, while a smaller portion (and indeed only the larger grains) takes on a distinct, uniform, and peculiarly dull luster. It is produced by numerous etching pits, which lie so closely crowded together that it is only under high magnification that they can be discerned or distinguished from one another. After stronger etching, the number of grains with etching pits is increased. Further, there appears, besides the sharply defined crevices which divide the grains, and within the former, still another system of irregular cracks, which under the microscope show as delicate veins; however, they do not, like the principal crevices, each define an individual, and may be a kind of fracture phenomenon. Finally there are a few grains which are rich in black, dull inclusions.

In other portions of the Kendall County iron which contain much less secondary material, the carbon-schreibersite veins between the grains are wanting. Only a small portion of the latter show the Neumann etching lines; the greater part become uneven after etching and show under the microscope numerous black, dull inclusions (above referred to), which can be studied more exactly here. They are sometimes grains, sometimes rods; and as the latter intersect one another at right angles, they give rise to a knitted appearance. This accordingly may be that formation which Brezina called "a peculiar skeleton" structure, and which he regarded as of only occasional occurrence. According to the appearance and the behavior after etching, a carbonaceous substance appears to be present; evidence to the same effect is found in the high percentage of carbon (1.62 per cent), although a specimen was used for analysis which contained no visible carbon.

Isolated schreibersite of greatly differing size occurs abundantly in the nickel-iron; especially noteworthy is a crystal from a small mold whose kernel of nickel iron possesses exactly the form of the host. Of troilite only grains a few millimeters in size were observed, which lay sometimes in the nickel iron, sometimes in the carbon. Brezina may, indeed, have taken many schreibersites for troilite, a mistake easily made when the former turns yellow. Black veins of eisenglas run from the original surface into the interior. The Kendall County iron dissolves very easily in dilute hydrochloric acid, with development of carburetted hydrogen. In this manner the following minor constituents were isolated: Amorphous carbon, black veins, schreibersite, silicate grains, and a hitherto unnoted cristobalite-like silica.

The latter occurs by preference or exclusively in intimate union with the carbon and the carbon-schreibersite concretions, since the pieces rich in the latter furnish the largest share, and the isolated constituents (carbon, schreibersite, and black veins), according to the analysis, give a mixture of silicic acid found nowhere else in meteoric iron and which can be referred to no mineral as yet observed in meteoric irons. The cristobalitelike crystals are small, very sharply outlined, colorless, and isometric. Some are clear, others turbid. On strong magnification one recognizes pointlike inclusions which are generally pretty uniformly distributed, though at times aggregated to cause cloudiness. As a rule only the cube is present, but occasionally the octahedron appears in part subordinate, in part equal with the cube. Most of the crystals are ideally formed, but occasionally prismatic through a stronger development of four faces of the cube in one zone.

Somewhat more common, but still rare, are cube faces indented by growth along the edges. Most of the crystals are 0.03 to 0.04 mm. in size, but the dimensions rise to 0.09 and sink to 0.01 mm. The following properties were verified: Completely isotropic; index of refraction between 1.48 and 1.52; specific gravity, 2.3; no cleavage; not attacked by concentrated HCl or aqua regia; soluble in cold hydrofluoric acid; unchanged B. B. A few opaque grains (apparently chromite), as well as cloudy, apparently very much disintegrated silicate grains, accompany the cristobalite-like silica. Although the number of the cristobalitelike crystals was very considerable, it was not possible, on account of their small dimensions, to obtain enough material for an analysis.

The amorphous carbon behaves, under treatment with potassium chlorate and nitric acid, exactly as Moissan describes. The oxidation proceeds with extreme slowness, but it develops no trace of carbonic acid. Without closer investigation the carbon would be taken from its appearance for graphite, and this graphitic character may account for the resistance to strong oxidizing agents.

The dark fragments remaining after treatment of the insoluble residue with copper ammonium chloride, and which—disregarding the schreibersite inclusions—have the appearance of a homogeneous substance, were analyzed in the supposition that they were particles of eisenglas. They appeared, however, in the main to be a mixture of iron hydroxide and carbon with abundant intermixture of cristobalitelike silicic acid.

Kendall County takes on pretty strong permanent magnetism;[5] the specific magnetism was determined by Leick at 0.33 absolute units per gram.

Analyses:

I. Schreibersite; Scheerer and Fahrenhorst. Ia: After deducting insoluble residue.
II. Complete analysis; Fahrenhorst. IIa: Composition of the nickel-iron after deducting accessory constituents.
III. Amorphous carbon, specific gravity 2.24, Fahrenhorst.

	I	Ia	II	IIa	III
Fe	61.08	61.78	92.65	94.02	1.23
Ni	21.68	21.93	5.64	5.23	0.61
Co	0.37	0.38	0.78	0.72	
Cu	0.21	0.21	0.03	0.03	.....
Cr	.....	.....	0.01	.....	.....
C	.....	.....	1.62	.....	90.96
H	.....	.....	.....	.....	1.04
P	15.52	15.70	0.34	.....	.....
S	.....	.....	0.03	.....	.....
Cl	.....	.....	0.01	.....	.....
Insoluble residue	1.14	.....	.....	.....	.....
SiO_2	.....	.....	.....	.....	6.59
	100.00	100.00	101.11	100.00	100.43

IV. Fahrenhorst gives the following analysis of the black veins:

Fe_2O_3	47.57
NiO+CoO	1.29
C	29.50
SiO_2	7.21
H_2O	4.32
Chromite	1.17
Schreibersite	6.11
	91.77

From II above the mineralogical composition appears to be:

Nickel-iron	96.11
Schreibersite	2.19
Carbon	1.60
Daubréelite	0.03
Troilite	0.05
Lawrencite	0.02
	100.00

The meteorite is distributed, but the Vienna collection possesses nearly half the amount, 10,702 grams.

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KENTON COUNTY.

Kentucky.
Here also Independence.
Latitude 39° 5′ N., longitude 84° 30′ W.
Iron. Medium octahedrite (Om), of Brezina; Caillite (type 18), of Meunier.
Found 1889; described 1892.
Weight, 163 kgs. (359.5 lbs.).

This meteorite has been chiefly described by Preston,[1] an abstract of whose account follows:

The mass was found by Mr. Geo. W. Cornelius, about the middle of August, 1889, while cleaning out a spring on his farm, about 8 miles from Independence, Kenton County, Kentucky. It was buried 3 or 4 feet below the normal surface of the ground and interlocked in the roots of an ash tree. The finder allowed the mass to lie by the spring until August of the following year, when he removed it to his woodshed, where it remained until purchased by Ward's Natural Science Establishment, of Rochester, New York.

The mass weighed 359.5 pounds (163.0665 kg.) and measured 21 by 14 by 8 inches (533 by 356 by 203 mm.). In form in certain directions it very much resembled a Nautilus. It had numerous but mostly shallow pittings; a few deep pittings occurred, however, on one side. It was entirely devoid of crust.

Analysis by Davison gave:

Fe	Ni	Co	Cu	C	S	P	
91.59	7.65	0.84	trace	0.12	trace	trace	=100.20

The possibility of the fall of the meteorite having taken place July 7, 1873, is suggested from observations of people in the vicinity, but this does not seem very probable.

Meunier[2] placed the iron in the Caillite group and described the structure as follows:

Acids develop a figure in which kamacite predominates rather more than in the type. Tænite occurs in very thin foliæ wanting in certain parts. Inclusions of black matter occur here and there, often limited by the angular contours of the neighboring alloy. Masses of schreibersite in small lamellæ are irregularly disseminated through the mass. Troilite appears to be rare.

Brezina[4] described the structure as follows:

Independence (Kenton County) is distinguished by an unusual richness in small rounded troilite crystals which are pretty well distributed through the whole mass. The bands are long and grouped, often weakly bent through the whole group; fields abundant and large, mostly filled with fine-grained kamacite, often alternating with comb-like forms. Tænite weakly developed. Kamacite strongly granular, finely pitted, and of flaky dull appearance. The whole iron is somewhat altered, especially near the surface. Separation occurs at times along the tænite plates.

Leick [5] found that plates of the iron were capable of taking and retaining magnetism from an electromagnet.

Tænite from the meteorite was described by Farrington [6] as follows:

One of the sections of the Kenton County, Kentucky, meteorite in the Field Museum collection tends to decompose along the planes of structure marked by the Widmanstätten figures. The result of this decomposition is a separation of the mass into fragments bounded by octahedral planes, of a homogeneous alloy of iron-gray color between which lie thin, elastic plates of a tin-white color. The first alloy is undoubtedly kamacite, the second tænite. In order to compare this tænite with that known from other meteorites, some study of it was made. The fragments which it was possible to separate rarely exceeded 4 sq. mm. in surface. As plates, they were thin, elastic, and magnetic. The only feature noted regarding their surface was that it is often marked by parallel rows of minute ridges extending across the plate. Corresponding striations usually appear on the adjacent kamacite. The plates are soluble in copper ammonium chloride, and fusible with difficulty B. B.

In separating plates for analysis care was taken to use only those which could be completely isolated and showed no rust. This proved a laborious operation, and after considerable toil the amount that could be secured for analysis was only 0.022 gram. The analysis was made by Mr. H. W. Nichols. Iron was determined by titration with an n/100 potassium bichromate solution, and cobalt and nickel isolated by means of two ammonia and three basic acetate separations and then precipitated electrolytically.

While the extremely small amount used for analysis makes the chances of error larger than is desirable, it is believed that fairly accurate results were attained.

The analysis gave:

Fe	80.3
Ni and Co	19.6
	99.9

The iron is distributed, the Field Museum possessing about one-third.

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Kiowa County. See Brenham.

Knoxville. See Tazewell.

KOKOMO.

Howard County, Indiana.
Here also Howard County.
Latitude 40° 30′ N., longitude 86° 5′ W.
Iron. Cape Iron group (Hca), of Brezina; Octibbehite (type 1), of Meunier; granular to compact iron, with cubic streaks (Cohen).
Found 1862; described 1873.
Weight, 4 kgs. (Smith); 4 pounds 1.5 ounces (Cox).

The first description of this meteorite was given in the American Journal of Science,[1] as follows:

At a meeting of the Indianapolis Academy of Sciences, November 20, 1872, Prof. E. T. Cox presented a paper on a hitherto undescribed meteorite, which was found in the year 1870, in digging a well on Mr. Freeman's farm, 7 miles southeast of Kokomo, in Howard County, Indiana, by Doctor Saville, who now lives in Sioux City, Iowa; and we are indebted to him for its preservation. It was presented to Prof. John Collett by the doctor last August, when he visited Sioux City, and it has been loaned to Professor Cox for examination and description.

The depth at which it was found in the well could not be satisfactorily learned; but from being embedded in plastic clay, which lies beneath a bed of peat, the probability is that, in falling, it met with no very great resistance until it reached this clay. It is a flattened, irregularly shaped mass, rounded on one side and concave on the other; the surface is darkened and covered with slight indentations. The dimensions are: Greatest length, 5 inches; average width, 3.5 inches; average thickness, 1.7 inches; its weight is 4 pounds 1.5 ounces, avoirdupois. A small piece has

been cut from one edge, and it is said that the smith broke two chisels in the operation. The fracture is granular, like fine steel, and the cut surface has a silvery appearance; it is malleable and somewhat harder than common bar iron, and, like the latter, it may be wrought into all manner of shapes. This meteorite only came into the professor's hands a few days ago, and, owing to the press of other work, he is able at this time to give nothing more than the result of a partial chemical analysis. It is destitute of stony matter, and the principal element is iron; next comes nickel; then, in small quantities, cobalt, tin, carbon, phosphorus, and probably a trace of sulphur. Submitted to the action of acids, the Widmannstätten figures are brought out in great perfection. At what time this meteorite fell is not known, but it is hoped that by calling the attention of the citizens of Howard County to the subject we may receive information regarding its history which will still further add to its scientific value.

About a year later an account was published by Smith,[2] as follows:

The mass of meteoric iron described below possesses peculiar interest from the fact that it was not found on the surface of the ground, but beneath the soil, although not to any very great depth. In 1862, a farmer, Mr. E. Freeman, while excavating a ditch in Howard County, Indiana, struck, at a depth of nearly 2 feet, a hard mass that attracted his attention; and owing to its unusual weight he preserved it. The earth penetrated consisted of stiff clay beneath 4 inches of black soil, so that the mass was embedded in the clay. This clay was colored by oxide of iron arising from a slight decomposition of the surface of the meteorite, the iron being one of those that decompose but slightly from atmospheric agencies. This meteorite was lost sight of for a number of years, having fallen into the hands of those not interested in matters of natural history, and only recently was sent to me for examination.

The form of the meteorite is an irregular elongated oval, and it has the indentations of the surface found on most meteoric irons. Its weight is 4 kg. The alteration at the surface is very slight, considering the length of time it must have remained beneath the soil, and fresh cut surfaces retain perfectly their brightness. The specific gravity is 7.821.

The composition of the meteorite is as follows:

Iron	87.02
Nickel	12.29
Cobalt	.65
Phosphorus	.02
Copper	trace
	99.98

A polished surface, when treated with nitric acid or bromine water, does not give the slightest indication of Widmannstätten figures so characteristic of most meteoric irons.

Smith's account will be seen to differ from that of Cox in several important particulars. These include the year of find, the weight, and the absence of Widmannstätten figures.

In consequence of these contradictory statements, Fletcher leaves the year of discovery doubtful ("1862 or 1870"), and Wülfing mentions the occurrence of two pieces of 4,000 and 1,850 grams weight, respectively.

Cohen[8] remarks that—

Since, according to Smith, the mass remained unnoticed for several years, it is probable that it was found in 1862 by Freeman, while its meteoric nature was discovered in 1870 by Saville. Further, it appears from the agreement of the place of discovery and the manner of the same to consist of one mass; since 4 kg., the weight in round numbers, agrees closely, as to figures with the 4 pounds 1.5 ounces given by Cox, it may be assumed that one or other of the two authors confused pounds and kilograms.

Meunier[3] supposed that the content of nickel had been placed too low by Smith, and arbitrarily assumed that it approached that of Octibbeha. He combined Kokomo and Octibbeha in one group whose representative should be Octibbeha, consisting of $FeNi_2$ (with 61.71 per cent Ni+Co). He gives the specific gravity as 6.79, which is evidently too low for an alloy so rich in nickel, and can be explained only by hollow spaces, which must be so numerous that they can scarcely escape observation.

Brezina[4] compared Kokomo with Smithland in 1885; the groundmass has the same velvety appearance, but materially lighter color. In 1895,[6] he included Kokomo with the Cape iron and Iquique in a division of hexahedrites distinguished by etching bands and oriented sheen.

Cohen[7,8] described the iron as follows:

By etching the iron takes on a varnishlike luster like that of Morradal and Smithland, but differs essentially from the latter in the occurrence of uniform parallel etching bands, which are so characteristic of the Cape Iron and Iquique. Two groups of such bands were observed, one of which consists of a band 3.5 mm. wide, upon which at a distance of about 0.5 mm. upon one side are three fine bands scarcely 0.25 mm. wide, while on the other side only one equally small band is present. * * * The other group makes a band 2 mm. wide, which splits in some places and then unites again. The finer bands also occasionally split up. These stripes are darker or brighter according to the position of the plate with reference to the light, like the body of the nickel iron, and in a certain position the reflection of

the entire surface is perfectly uniform. Under a moderately strong magnifying power Kokomo appears as an entirely homogeneous mass, with the exception of extraordinarily small, strongly reflecting points. At first, by the employment of a magnifying power of about 200 diameters, one sees a succession of dark, faint, and bright, glistening particles; since one can not distinguish a distinct line of demarcation between one and another of them, it is not possible to determine definitely whether the structure is granular or whether the appearance is due to etching pits. I consider the former the more probable. No accessory material of any sort is noticeable.

After stronger etching the surface of the section becomes dull and finally uneven, owing to the formation of small round pits closely packed together; the ascertainment of the structure is not thereby furthered, however. Analysis by Sjostrom gave:

Fe	Ni	Co	Cu	P	S	
83.24	15.76	1.07	0.01	0.08	trace	=100.16

Specific gravity (Leick), 7.8606.

Cohen classed the meteorite as a compact iron with hexahedral streaks, placing it in the same group with the Cape iron, etc.

Only 655 grams of this iron are recorded in collections. Harvard has the largest amount, 418 grams. The whereabouts of the main mass seem to be unknown.

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Kossuth County. See Forest City.

LA CHARCA.

Near Irapuato, State of Guanajuato, Mexico.
Here also Irapuato.
Latitude 20° 53′ N., longitude 100° 55′ W.
Stone. Chondrite (C) of Brezina.
Fell 11.30 a. m., June 11, 1878.
Weight, 399 grams (14 ozs.).

Little seems to be known regarding this meteorite. It is merely mentioned by Vom Rath,[1] Brezina,[2] and Castillo.[3] Under the name of Irapuato Castillo [3] says that the meteoric stone of Irapuato fell June 11, 1878, between 11 a. m. and noon. Its weight, he states, was 399 grams. He says that it has been described by Prof. S. Navia of the College de Guanajuato. Vom Rath [1] states that the same college possesses the whole stone. No specimens seem to have reached other collections.

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LA GRANGE.

Oldham County, Kentucky.
Here also Oldham County.
Latitude 38° 25′ N., longitude 85° 30′ W.
Iron. Fine octahedrite (Of) of Brezina; Jewellite (type 9) of Meunier.
Found 1860; described 1861.
Weight, 51 kgs. (112 lbs.).

The first account of this meteorite was given by Smith,[1,2] as follows:

The announcement of the discovery of this iron meteorite was made in a note in the American Journal of Science and Arts. It was discovered in the month of October, 1860, by Mr. William Daring, near La Grange, in Oldham County,

Kentucky. There is nothing known with reference to the time of its fall. It came into my possession shortly after its discovery. It was entire and weighed 112 pounds. Its extreme dimensions were: Length 20, breadth 10.75, and thickness 6.5 inches; its shape was elongated and flattened. Its specific gravity is 7.89, and an analysis furnished:

Fe	Ni	Co	Cu	P	
91.21	7.81	0.35	trace	0.04	=99.10

Cohen [11] has given a further account of the meteorite, as follows:

Reichenbach [3] noted bronze-colored iron sulphide and Eisenglas; Rose,[4] very fine Widmannstätten figures.

Meunier [5,6] regarded La Grange as a characteristic example of the occurrence of plessite, and used the iron according to his method (heating filings on a glass plate and noting the colors) to isolate kamacite, tænite, and plessite. The method can not, however, yield a serviceable result generally regarding the intimate structure of a meteorite, and certainly can not here on account of the fineness of structure. Later,[9] he stated that La Grange and Jewell Hill consisted of equal portions of tænite and plessite and combined both together with Bückeberg in his Jewellite group.

The lamellæ are long, straight, considerably compacted, and about 0.15 mm. broad. A peculiar fibrous appearance and a somewhat silken, oriented luster are characteristic of the kamacite. This luster is sometimes explained by the fact that the abundant hatching frequently runs parallel to the bands or intersects them at acute angles; but the same luster shows itself where this is not the case, and may there be caused by a large number of closely compacted etching pits, which, however, do not become visible except under considerable magnification. The few small fields are filled with dark plessite, which, under the microscope, appear rich in tiny, glistening, uniformly distributed spangles. In the quite numerous, larger areas the structure of the iron as a whole is repeated. Since the lamellæ are but slightly smaller here than the principal lamellæ and the tænite scarcely appears, these large fields do not show up prominently, and the etching surface has an unusually peculiar appearance.

Minor constituents appear to be scarce and of small size. Schreibersite was observed only in a few particles 2 mm. in size. In a specimen in the Vienna collection the troilite is distinguished by an abundance of daubréelite bands, of which as many as four occur in one crystal of 0.75 mm. in thickness and 6 mm. in length. In the other sections examined daubréelite is wanting entirely, so that its distribution, as usual, is very irregular. Recently, Brezina [10] made mention of Reichenbach lamellæ with bent borders, which show faulting. In the neighborhood of the natural surface a little Eisenglas occurs. Meandering cracks, frequently intersecting the lamellæ, spread out quite extensively in the interior.

Analysis by Bürger:

Fe	Ni	Co	Cu	Cr	P	S	
91.92	7.61	0.62	0.01	0.02	0.03	0.02	=100.23

The meteorite is distributed, but the largest quantity, 85 pounds, is in the Amherst collection.

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La Grange, 1878. See Bluff.

LANCASTER COUNTY.

Nebraska.
Iron.
Weight, 13 kgs. (29 lbs.).

The only mention of this meteorite is by Barbour,[1] who speaks simply of having received such a meteorite.

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Laramie County. See Silver Crown.

LAURENS COUNTY.

South Carolina.
Here also Laurens Court House.
Latitude 34° 30′ N., longitude 82° 2′ W.
Iron. Fine octahedrite (Of) of Brezina; Carltonite (type 22) of Meunier
Found 1857; described 1886.
Weight, 2,220 grams (4 lbs. 11 ozs).

The principal account of this meteorite was given by Hidden,[1] as follows:

This undescribed mass of meteoric iron was found in 1857 in the northwestern corner of Laurens County, South Carolina, and was deposited soon after its discovery in the cabinet of the Laurensville Female College, at Laurens Court House, South Carolina. It remained there until it was sent to the Exposition at New Orleans in 1884 as a part of the South Carolina exhibit. The writer is indebted to R. W. Milner, president of the Laurensville Female College, for the above information, and also for the possession of the meteorite.

Its weight is 4 pounds, 11 ounces.

The perfection of the Widmannstätten lines, as shown in the smoothed surface, is unusual. Their fineness marks the mass as belonging to a class of rare meteorites.

The writer's attention was directed at first to the apparent cuboidal aspect of this mass, and with that idea, he had the panel smoothed out, merely to prove by the internal structure whether or not this shape was accidental.

The relation of the etched lines to the profile gives evidence that in part, at least, the outward shape is due to a uniform crystallization of the mass. The perpendicular lines are nearly parallel to the two sides (this is better proved while examining the mass in hand), and agrees fairly enough with the top and bottom sides to be consistent with a cube. The back of the mass is bluntly pointed (cone shape) toward the left upper side and covered with large depressions.

Wishing to further test the homogeneity of the mass, it was cut through at the base of the cone-shaped projection on the back and the surface (shown in a figure) developed. Here the internal structure is exhibited even more beautifully than in the smoothed surface and the angles are those which octahedral crystallization would present on a cubic face.

All over the mass a thin formation of limonite was observed, this coating being much thicker over the cuboidal faces than on the rough surfaces at the back. The thickness of this crust is well shown by a figure.

The dark rhomboidal spot near the middle of the section was found to consist of solid ferrous-chloride (lawrencite). Several similar spots of this same rare species were noticed on the same face. Their deliquescence first attracted attention to them. The presence of hydrogen (occluded) was proved by simply rubbing the smoothed surfaces with powdered sulphur, when instantly the disagreeable odor of hydrogen sulphide was made noticeable. In the action of nitric acid on the smoothed surfaces the presence of carbon was also proved conclusively.

A few words as to what seems to be the point of impact when this mass fell. On one edge a nearly straight surface of 2 cm. length was seen, and as this was a natural flat surface I smoothed and etched it. A set of lines, of structure of about 90° angle, was at once noticeable, as well as an increased fineness of detail as compared to the other figures. That this face is the place of impact the writer has no doubt after comparing its surface with the other figures.

A careful analysis by James B. Mackintosh yielded:

Iron	85.33
Nickel	13.34
Cobalt	0.87
Phosphorus	0.16
Sulphur	trace
Carbon (undetermined).	
	99.70

These results place this mass among the few that are exceedingly rich in nickel and cobalt. It approaches in this regard the meteorites of Babb's Mill (Green County, Tennessee), Ni 14.73 per cent (mean of three analyses), and that of Kokomo (Howard County, Indiana), Ni 12.29 per cent. Its cobalt percentage is probably above that of any other on record, being nearly 1 per cent.

Meunier[4] referred the meteorite to his group carltonite and described it as follows:

Acids give a very remarkable figure with the kamacite in elongated, straight bands, bordered on either side by a lamella of tænite. Associations of this sort are often grouped in the form of bundles which intersect in the angles of the octahedron. The spaces are filled with carltonite. Neither pyrrhotine nor schreibersite are present.

Brezina [5] described the structure as follows:

Original weight of mass, 2,150 grams. Bands long, straight, much bunched, 0.17 to 0.27 mm. in width, containing close packed ribs of porous cohenite. Granular kamacite, with oriented luster. Tænite strongly developed. Fields large and irregular, plessite predominant, dark gray, occasionally showing half obscured repeating lamellæ in the fields.

Cohen [6] reviewed previous accounts of the meteorite and described its structure as follows:

According to Hidden this iron was covered with rust, and in the main possessed a cubic form with a conical projection and a somewhat convex face full of large pittings. There was a flattening on one surface, and since the Widmannstätten figures appeared to be distorted at this point, Hidden supposed that the mass struck at this place. Although the lamellæ sometimes according to their position are said to show relations to cubic faces, this is not observable upon the figure accompanying the article. Upon a cubic section surface the lamellæ must intersect one another at right angles. In the middle of a section several particles of solid iron chloride were observed; in the cut they seem to be surrounded with swathing kamacite, which would indicate that it was an original constituent present before the crystallization of the kamacite, if it were not observed that a pseudomorphous formation occurred here. Hidden stated that by rubbing a surface with sulphur the smell of hydrogen sulphide was made noticeable and he attributed this to occluded hydrogen. This could not be true, however, since sulphur and hydrogen do not unite except at a higher temperature.

Meunier referred Laurens and Carlton to a separate group, "Carltonite," since he considered the plessité an independent alloy of nickel (Carltonin), which played the part of plessite in other octahedrites. Carltonine is much more difficult to oxidize, finer-grained, and contains no combs. He further emphasized the absence of iron sulphide and schreibersite in the Laurens iron.

The bands vary from 0.17 to 0.27 mm. in width and are long, straight, often grouped, granular, and give an oriented luster. They often contain throughout their entire length, grains and elongated crystals, which are arranged with larger or smaller interstices between, and do not seem to be connected; the larger these grains, the broader the bands. Whether this substance is cohenite, as Brezina recently conjectured, or schreibersite, requires a more exact investigation to determine. The tænite is well developed and is sharply distinguished from the kamacite. The strongly predominating fields are of varying dimensions, free from combs and consist of dense, dull, dark gray plessite, which is sometimes shimmering and sometimes contains central skeletons. The grains and ribs in the kamacite are apparently mingled with some troilite, which also occurs in a few small, irregular grains, bordered with a delicate wreath of schreibersite grains and all these together inclosed in swathing kamacite.

Laurens has an alteration zone 4.5 mm. wide.

The iron is principally (1,537 grams) preserved in the Vienna Museum.

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Lea Iron. See Cleveland.

Leavenworth County. See Tonganoxie.

Leland. See Forest City.

LEXINGTON COUNTY.

South Carolina.
Latitude 33° 58′ N., longitude 81° 7′ W.
Iron. Coarse octahedrite (Og), of Brezina; Bendegite (type 6), of Meunier.
Found and mentioned, 1880; described, 1881.
Weight, 4.75 kgs. (10.5 lbs.).

This meteorite was chiefly described by Shepard,[1] his account being substantially as follows:

This iron was found on the land of a farmer in Lexington County, South Carolina, who supposed it to be a valuable ore, indicating a mine on his property. On learning its true character, he sold it to Prof. C. U. Shepard, jr., of the Medical College at Charleston.

Its weight, as first found, was 10.5 pounds. Its shape was that of a cylinder with two flattened edges and somewhat compressed at the ends; on the whole, approaching most nearly to the shape of a very transverse bivalve. Unlike many of the iron masses found in the soil, the surface of the present specimen is nearly free from yellow hydrated peroxide of iron, being mostly enveloped with a black and brittle coating, which, though containing some turgite, is yet mostly formed of magnetite. The general surface is smooth, though presenting a few broad but shallow depressions. A series of amygdaloidal masses of troilite, the largest being of the size of filberts, traverses the body near the end which has been sliced, and where they were so abundant as to constitute for a considerable space nearly one-third of the aggregate, while elsewhere they scarcely come into view, except in remote amygdules. Where the scaly coating of magnetite is thin or wholly wanting a coarse crystalline structure appears, but without any very continuous lamination. The slicing is not difficult unless the saw encounters troilite or magnetite, the latter of which, associated with traces of graphitoid, envelops the former and also exists elsewhere in the immediate vicinity of the amygdules, in a coarse network of veins. The existence of the seams occasionally aids in the separation of small fragments of the iron, between whose layers it seems to have insinuated itself and acted as a rupturing force. This circumstance is worthy of notice as a possible cause of the disintegration and detonation of meteorites while traversing our atmosphere.

The most interesting feature by far of the Lexington iron is that of its remarkable analogy in structure and composition with the Bohumilitz iron, found in 1829, the resemblance of their etched surfaces being so strong that they might very easily be confounded. They are the only two irons which strikingly give the moiré métallique luster. The chief difference between the two consists in the thickness of the crystalline bars, which in the Lexington iron is nearly double that of the other. In both their walls are alike, broadly undulatory or wavy; and the included spaces are filled with closely crowded points of rhabdite and extremely minute lines of tænite, crossing each other at all angles from 90° to 150°. In passivity it far surpasses any iron hitherto discovered. Schreibersite also occurs in smal quantity along with the graphitoid and magnetite. It shows no signs of chemical alteration by exposure to the air, in which respect also it agrees with the Bohumilitz.

The specific gravity of the entire mass was 7, that of homogeneous fragments 7.405. Analysis by Prof. C. U. Shepard, jr., gave:

Fe	Ni	Co	Mn	Sn	P	Insoluble residue	
92.416	6.077	0.927	trace	trace	trace	0.264	=99.684

Meunier [2] described the iron as follows:

The unique specimen of the Lexington iron in the possession of the Paris Museum is very small. It is sufficient, however, to identify this fall with the type bendegite. It develops etching figures entirely characteristic of this type.

Brezina's [3] description is as follows:

The bands have crumpled edges with interwoven shreds of tænite. The kamacite is deeply hatched. Oriented rhabdite and etching pittings are abundant. Fields are very scarce and entirely filled with ridges resembling the kamacite in appearance. The large, elongated, and irregular troilite concretions have a band of schreibersite which penetrates the troilite.

The iron is somewhat distributed, the Shepard collection in Washington possessing the largest amount (3,992 grams).

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LICK CREEK.

Davidson County, North Carolina.
Latitude 35° 40′ N., longitude 80° 16′ W.
Iron. Hexahedrite (H); Braunite (type 3), of Meunier.
Found 1879; described 1880.
Weight, 1.24 kgs. (2.75 lbs.).

This meteorite was first described by Hidden [1] as follows:

On July 19, 1879, Mr. Gray W. Harris, while out prospecting for gold on his land near Lick Creek, Davidson County, North Carolina, found an unusually heavy stone of the size of a large pear, which he at first mistook for a specimen of iron ore. On attempting to break it he found that the stone would not break but was covered with a uniformly thick skin or crust, which scaled off under repeated blows of the hammer.

After carefully removing all he could of this crust, there remained a pear-shaped mass of what appeared to him to be a pure metal. The color of the metal developed by hammering was white, and this led him to conclude that it was silver. This "nugget of silver," as he called it, soon had a wide notoriety among all the mining camps in the vicinity.

This story, substantially as above related, reached me at Concord, North Carolina, in the autumn of 1879, my informants being the Messrs. Richard Eames, jr. and sr. They had seen the nugget and believed it to be iron, perhaps native iron; they had noticed that the nugget had what Mr. Eames, jr., aptly termed "night sweats." Little beads of a yellowish fluid would gather upon its surface over night, which, if wiped away, would form again in the next 24 hours.

This last addition to the story of the "silver nugget" convinced me that the mass was really meteoric iron. After no little trouble and expense it was finally sent to Menlo Park, New Jersey, where it was at once recognized as meteoric iron. But for the active interest taken in this meteorite by the Messrs. Eames, it would have been in all probability lost to science, and I take this opportunity to express my indebtedness to them.

Its weight when received here was 2.75 pounds (1.24 kg.). Its outward color is dark brown, not rusty, and some little of the original crust yet adheres to it. The crust of this meteorite is of unusual importance and quite unique. It averages 1 cm. in thickness and resembles a hard, dark slate, shows a lamellar structure, and readily breaks into flakes. Some cavities in this crust are lined with mammillary forms, and it has many seams with a vitreouslike luster. Last month I visited the spot where the meteorite was found and collected about 6 ounces of the crust. It lay there exactly as Mr. Harris had broken it off. I had no fears of mistake in identifying this crust, as all the local gravel was composed of white quartz pebbles. The iron has been analyzed by Dr. J. Lawrence Smith and J. B. Mackintosh. I here give the average of four closely agreeing analyses, as follows:

Fe	Ni	Co	P	S	Cl	Cu	C	
93.00	5.74	0.52	0.36	traces	traces	traces	undt.	=99.62

The iron does not show the customary Widmannstätten figures. I have etched all the exposed surfaces and obtained no well-defined markings on a large scale, but I have found that the etched surfaces show crystalline faces that reflect the light at certain angles, giving a sort of sheen much like moonstone or labradorite. These reflecting surfaces are in parallel sets.

Meunier[3] grouped the iron as braunite and noted well-formed rhabdites which easily fall out under the action of acid, leaving cavities of exactly their shape.

Brezina[2] described the mass as of shallow, pitted form on one side and of a flat, arched form on the other. He goes on to say:

The loose, porous character of the iron in many places is very singular, especially in the vicinity of individual portions in close proximity to the exterior which have been altered to magnetite. Manifestly the change to magnetite would take place most readily where the structure of the iron was spongy. Such porous iron particles rust very rapidly, becoming lusterless a few minutes after polishing.

In common with Coahuila, Lick Creek shows daubréelite-bearing inclusions of troilite; and as there the daubréelite cuts the troilite in straight lines, so that here also it must be supposed that it is arranged in plates parallel to (001). Rhabdite is prominently developed, having a length of as much as 4 mm. and a breadth of 0.5 to 0.7 mm.

In 1895,[4] Brezina noted that the coating of rust lying parallel to the exterior surface apparently originated from the veinless underside and that the much veined upper side strongly resembled that of Canyon Diablo. According to Hidden's picture of the meteorite, Cohen[6] thought this comparison unwarranted.

Cohen[6] further described the structure of the iron as follows:

Lick Creek etches readily; the Neumann lines are numerous, fine, and uniformly distributed, as is usually the case. One system comes out more prominently here than the rest because of the length and sharpness of the lines, but in general the etching lines are of unusual length and generally attain to the full diameter, so that they cover the etched surface like a tolerably regular network. The large rhabdites have a tendency to cluster together and are regularly arranged, the fine needles (0.25 mm. long by 0.015 to 0.025 mm. thick) being present in considerable numbers quite uniformly distributed and parallel to one another. The oriented luster is weak. The characteristically porous, easily rusted portions occur only in the neighborhood of the natural surface, and here the etching lines and the luster are wanting.

Leick[5] determined the specific gravity at 7.5869. The low figures are certainly due to the porous character of some portions and accordingly pieces of this meteorite, when placed under the air pump, develop air bubbles much longer than do other irons. Lick Creek takes on permanent magnetism distinctly and yields a specific magnetism of 0.27 absolute units per gram.

The meteorite is chiefly (950 grams) in the Vienna collection.

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Lime Creek, 1832. See Walker County.

Lime Creek. 1834. See Limestone Creek.

LIMESTONE CREEK.

Near Claiborne, Monroe County, Alabama.
Here also Claiborne (in part), Lime Creek, Morgan County, and Walker County (in part).
Latitude 31° 32′ N., longitude 87° 30′ W.
Iron. Ataxite, Cristobal group (DC) of Brezina.
Found 1834; described 1838.
Weight uncertain. Original mass described as "of irregular triangular shape 10 inches long by 5 or 6 inches in thickness."

This meteorite has been much confused with that of Walker County and with a pseudo-meteorite. Without doubt, however, it is a distinct meteorite with well-defined characters, the most remarkable of which is its high content of nickel. The first description of the meteorite was by Jackson[1] who stated that it came from Lime Creek, near Claiborne, Alabama. The creek in the vicinity of Claiborne is, however, given in all atlases as Limestone Creek, not Lime Creek. Shortly after, the meteorite of Walker County, Alabama, was discovered and distributed, and as neither the Lime Creek nor Walker County meteorites gave etching figures of the usual octahedral type, one, as now appears, being an ataxite and the other a hexahedrite, the two became much interchanged. With the true Walker County and Lime Creek became also mixed a pseudo-meteorite, distributed, as Cohen[7] concludes, by Shepard. While, according to present usage, the name Claiborne would be the appropriate one for the meteorite, it seems best, in view of the fact that the name Claiborne has also been used for the Tazewell meteorite to give it the true name of the creek, Limestone Creek.

The description given by Jackson[1] states that the mass was found on the surface of the earth and that it was of an irregular triangular shape, rounded at the corners. Its dimensions are given as 10 inches long by 5 or 6 inches in thickness. No weight is given, but it is stated that the mass was too heavy for one man to carry conveniently. A piece weighing 28 ounces was broken off with a sledge hammer, and it was this piece which was sent to Jackson[1] and from which his description was made. He states:

> This specimen was rounded on all sides excepting on that where it was fractured, which presents a rough, hackly surface with projecting bright silvery streaks and deep greenish and brown eroded surfaces from which an exudation of green liquid takes place on exposing the specimen to moist air. The rounded surface is coated with a thin layer of the subchloride of iron which being removed the mass is found to consist of metallic matter resembling wrought iron when the specimen is filed bright. On attempting to break off a fragment the mass was found to be extremely tough and malleable, so as to require the aid of a file and cutting chisel.

The specific gravities obtained on these separate fragments from different parts of the mass were 5.750, 6.400, and 6.500. Two analyses were made by Jackson as follows:

	1	2
Specific gravity	5.75	6.50
Fe	65.184	66.560
Ni	27.708	24.708
Cr and Mn (estimated)		3.240
S	.....	4.000
Cl	.....	1.480
	92.892	99.988

The high content of nickel of the meteorite was thus shown by Jackson in his first analyses.

In 1845 the composition of the iron was studied by Hayes,[3] and his report was as follows:

> An oval mass weighing about 8 ounces completely covered by a thick brown coating of oxide of iron from atmospheric exposure had a portion of its surface filed bright. This was then etched with dilute hydrochloric acid. After washing the mass in pure, warm water it exhibited the appearance of inlaid work produced by the arrangement of delicate, brilliant folia, or was dotted by minute crystalline portions of pyrites. The color of the general surface was light gray. Under a lens the texture resembled that of ductile iron containing innumerable glittering points of unequal size. It could be polished, but under the file or with cutting instruments. It had the characters of cast iron and would

not afford shaving. There were a few dots of an earthy mineral or rock, having a magnesian base, closely adhering to fragments of pyrites.

A fragment was analyzed by Hayes with the following result:

Fe	Ni	FeS_2	Cl	Loss	
83.572	12.665	2.395	0.907	.461	=100

It is thus seen that Hayes' analysis, while showing a high content of nickel, does not exhibit the percentages obtained by Jackson. Hayes' account indicates that his specimen was a complete individual and not a fragment from the original specimen. One must conclude, therefore, that either his or Jackson's analysis was faulty or that they worked on different meteorites.

Partsch [2] examined a small piece of the meteorite sent him by Jackson and found it not attacked by dilute nitric acid. After strong etching with concentrated nitric acid, the iron showed neither Widmanstätten figures, lines, streaks, or bands. A polished surface showed but little luster, was grayish black in color and exhibited grains, lines, and points of iron sulphide in so large quantity and uniform distribution as to differ from any iron that he had previously examined.

Meunier,[4] in 1884, united the iron with that of Tucson, the characters of the group being "compact, taking a good polish, and inclosing very small stony grains." In 1893,[5] he changed the classification of Lime Creek to the braunite group and described the specimen as follows:

In the Paris Museum there is a specimen of this iron with the following label, in Jackson's own handwriting: "Meteoric iron in which I originally discovered chlorine combined with nickel and iron, in 1834." The metal is not very compact, filled with small cavities which contain a black substance. A few bright grains resembling schreibersite may be seen with the glass.

Cohen [6] described the structure of the iron as follows:

The iron acquires, upon etching, a glossy luster such as is characteristic of nickel-rich ataxites and especially resembles Morradal. To the naked eye the surface appears somewhat speckled, but under the microscope these boundaries disappear entirely and the appearance is that of a homogeneous compact iron. When very highly magnified, dark rods and points about 0.001 mm. in cross section appear in great numbers, giving the appearance of a netted structure of extraordinary fineness. These are, however, not uniformly distributed and disappear on some regularly arranged elongated areas 0.01 mm. in breadth. The latter appear clear, lending a hackly appearance to the surface, and may well be the cause of the previously mentioned speckled appearance. The minute size of the inclusions makes a study of the structure and description of it difficult. Besides some large schreibersites there are pretty uniformly distributed a considerable number of little rods, grains, and spindles, all surrounded by a small, dull zone face of dark grains. These would seem to be iron-nickel phosphide also. They sink on the one hand to microscopic dimensions and on the other reach at times a length of 0.75 mm. To their falling out may perhaps be ascribed the depressions seen on an etched surface.

A fragment of the iron weighing 0.3 gr. was analyzed by Dr. Knauer, with the following result: I, analysis; Ia, the analysis calculated to 100 after discarding residue and iron-nickel phosphide:

	Fe	Ni	Co	P	Residue	
I	65.03	29.99	1.48	0.19	0.20	= 96.89
Ia	67.41	31.06	1.53	....	.....	=100.00

Tests for metals of the hydrogen sulphide gave no result, and the residue gave no reaction for chromium. The above analysis supports Jackson's results.

As Cohen remarks, most of the specimens labeled "Lime Creek" in collections will be found to be Walker County. Such as are truly from the iron described by Jackson can be known by their lack of hexahedral characters and by their high content of nickel.

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Lincoln County. See Petersburg.

Linn County. See Marion.

LINVILLE.[a]

Linville Mountain, Burke County, North Carolina.
Latitude 35° 48′ N., longitude 81° 55′ W.
Iron. Nickel-rich ataxite, Morradal group of Cohen.
Found about 1882; described 1888.
Weight, 442 grams (15.5 ounces).

This meteorite was described by Kunz,[1] as follows:

A mass of meteoric iron was found on Linville Mountain, Burke County, North Carolina, about the year 1882. It was handed to a country blacksmith in the vicinity, who sold it to a tourist miner, and finally it came into my possession.

The meteorite weighed 428 grams; the original weight being 442 grams (15.5 ounces), the balance having been used for analysis and for etching, and measured 65 by 35 by 38 mm. One side is rather rough and the other is pitted with very shallow pittings. Traces of a black crust of magnetic oxide of iron are still visible, and although the mass is not rusted, yet small drops of chloride of iron have collected in the deep clefts, and in one of them was found a spider's egg case, suggesting either that the iron is a recent fall or had been found on the surface of the ground.

In cutting a piece from the lower side, the blacksmith destroyed considerable of the surface as well as the crust, on account of the toughness of the iron. The iron admits of a high polish, yielding a rich nickel color, which, under the glass and by reflected light, shows an apparent network of two distinct bodies. On etching, the surface of the iron merely blackens and does not show the Widmannstätten figures. If this black deposit is washed off, an orientated sheen appears. Almost the entire surface has, under the glass, the appearance of a meshwork of which the irregularly rounded centers have been eaten out. At a few places on both sides of a crack is a small piece of troilite 3 by 1.5 mm., through which are scattered small patches of meteoric iron that after etching exhibit beautiful octahedral markings so delicate as to be invisible to the naked eye, and somewhat like those of the Tazewell meteorite, though not more than one-tenth the thickness.

Analysis by J. E. Whitfield:

Fe	Ni	Co	S	C	P	
84.56	14.95	0.33	0.12	trace	trace	=99.96

Brezina, in 1895,[2] placed the meteorite in the Chesterville group and described it as follows:

The etched section surface shows a peculiar constitution, which on the one hand resembles the iron of Victoria West, by reason of its extraordinary richness in schreibersite granules, flakes, and lumps; and on the other hand, resembles that of Shingle Springs, on account of the irregular stratification. While the principal part consists of a very intimate and uniform mingling of schreibersite granules with a darker, structureless groundmass, larger schreibersite individuals are found in connection with hollow places, which consist of dark iron with a thin coating of schreibersite and are broken by small laminæ which likewise are made of dark iron with a coating of schreibersite. The placing of this iron in the Chesterville group is by no means perfectly certain, although most of the analogies speak for this assumption.

Cohen [3] described the iron as follows:

A piece of the Linville meteorite weighing about 200 grams, with a section surface of 18.5 sq. cm., representing nearly one-half of the entire fall, was at hand for examination. The outer surface consists of a fusion crust of varying thickness, which is worn off where it is particularly thin. In one place a cleftlike depression extends from the surface toward the interior to a depth of 2½ cm. On other portions of the surface there are deep, very irregularly formed cavities which show no similarity whatever to the usual saucerlike depressions or finger marks; the one cavity ends with a canal 1 cm. long and 1 mm. wide, in the interior of the piece. The formation of these hollows may be occasioned by the melting out of schreibersite; since isolated holes occur upon the section surface which show, by their form or the remaining of the material, that they were originally filled with schreibersite. The larger individuals remaining of the latter attain a length of 10 and a width of 1.5 mm.; it occurs also in tiny spangles and rhabditelike needles. Iron sulphide is not noticeable; what Kunz described as troilite may be yellowish, tarnished schreibersite.

The principal part of the nickel-iron takes on by etching a similar, although weaker, varnishlike gloss, like that so characteristic of Morradal and Smithville. The structure appears to the unaided eye exceptionally uniform and fine grained. Nevertheless, even under a strong glass one can distinguish distinctly raised, strongly reflecting portions and dark dull depressions; the etched surface appears as if covered with tiny, densely packed, uniformly distributed pinholes. With a higher power of the microscope, it appears that the glossy particles form a meandering vein structure of the finest possible texture, the threads of which have a width of 0.02 to 0.04 mm., and that the sunken portions sometimes possess a roundish to cylindrical form, sometimes an elongated vermiform character, both having

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[a] The spelling Linnville was given by Kunz and has been followed by other authors, but charts of the region give Linville.

about the same dimensions as the raised portions. If one considers the larger schreibersites, or rather the hollows formerly filled by them, the number of the hollow places decreases, the form of the latter becomes distinctly fusiform, and finally there prevails around the schreibersite a nickel-iron with usually a smoother etching surface and of mostly darker color. Only isolated, groovelike depressions occur on this nickel-iron, always surrounded with an exceedingly fine, bright band. Where it is somewhat thicker it gives rise to portions with a prettily netted appearance. These peculiarly constructed etching bands surrounding the schreibersite give the etched section of the Linville meteorite a very characteristic appearance, different from that exhibited by any other meteoric iron.

Analysis by Sjöström:

	Fe	Ni	Co	Cu	C	P	S	
Total composition....	83.13	16.32	0.76	0.02	0.11	0.23	0.02	=100.59
Nickel-iron.....	83.07	16.05	0.75	0.02	0.11	....	....	=100.00

The comparatively high content of carbon accounts for the fact that, by etching, the iron becomes coated with a black, easily removable substance.

Mineralogical composition:

Nickel-iron	98.46
Schreibersite	1.49
Iron sulphide	0.05
	100.00

Specific gravity (Leick), 7.4727, of 202.5 grams at 15° C. This low figure for an iron so rich in nickel is doubtless to be referred to the occurrence of hollows in the inner part of the tolerably large pieces, and this is the more probable since hollows occur on the surface and upon the cut faces in large numbers. This meteoric iron shows only traces of polar magnetism and gives a specific magnetism of 0.29 absolute units per gram.

Linville belongs to the ataxites rich in nickel without etching bands and etching flecks. It has the varnishlike gloss produced by etching, in common with the Morradal and Smithville meteorites; it is distinguished from the other representatives by a somwehat finer grain, by the pin-pricked etching surface, as well as by the peculiar etching zone which surrounds the schreibersite. If we would make still further subdivisions, we may distinguish, in addition to the Babbs Mill group, a Linville group.

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The meteorite is somewhat distributed, Vienna possessing the largest quantity (214 grams).

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LITTLE PINEY.

Pulaski County, Missouri.
Here also Pine Bluff.[a]
Latitude 37° 55′ N., longitude 92° 5′ W.
Stone. Spherical chondrite (Cc), of Brezina; Montréjite (type 38, subtype 1), of Meunier.
Fell 3.30 p. m., February 13, 1839.
Weight: Variously given, Shepard says 50 pounds.

The first account of this meteorite was by Herrick,[1] as follows:

On the afternoon of February 13, 1839, a meteor exploded near the settlement of Little Piney, Missouri (latitude 37° 55′ N.; longitude 92° 5′ W.) and cast down to the earth one stony mass or more in that vicinity. Mr. Forrest Shepherd, of this city, who was at the time exploring this region in the line of his profession, viz, that of a mineralogical and geological surveyor, hearing of the explosion of the meteor, exerted himself to collect all of the circumstances of the occurrence. He subsequently succeeded in obtaining several fragments of one of the stones thrown down by the meteor. Mr. Shepherd has favored me with an opportunity to examine these fragments, and has also communicated to me the details below related.

The meteor exploded between 3 and 4 o'clock p. m., of the 13th of February, 1839, and although the sky was clear, and the sun of course shining at the time, the meteor was plainly seen by persons in Potosi, Caledonia, and other towns near which it passed. At Caledonia, which is about 9 miles southwesterly from Potosi, the meteor passed a little north, and at the latter place, a little to the south of the zenith. Its course was almost precisely to the west. The most eastern spot at which it was seen is about 15 miles west of St. Genevieve, or about latitude 37° 50′ N., longitude 90° W.; the most western is Little Piney, near which it exploded. To the observers at the latter place, the meteor appeared of the size of a large star. They represent its motion as very slow; but do not state how many seconds it was in sight. We have no data for determining the meteor's size or velocity, or the inclination of its path to the horizon. The direction of the meteor's motion with regard to that of the earth was probably such that the velocity of the

[a] The name Pine Bluff would be more appropriate for this meteorite than that of Little Piney, since the fall occurred, according to Shepard, only 2 miles from Pine Bluff but 10 miles from Little Piney. Although both of these places seem to have been post offices at the time of the fall, neither exists at present. As the name Little Piney has become better known by usage it may as well be retained.

former would be apparently diminished; and as at Little Piney the meteor must traverse only a small arc, its motion, to an observer there, would appear quite slow. At the time of the occurrence Mr. Shepherd was on the western bank of the Mississippi, near St. Marys Landing, and heard a distinct report, which he was afterwards inclined to refer to the explosion of this meteor. At Little Piney, Mr. Harrison and others saw the meteor burst in pieces, and in a minute or a minute and a half afterwards they heard three explosions in quick succession. Some of the inhabitants went in quest of the stones which they supposed had fallen, and finally found a tree which appeared to have been recently injured by the collision with some solid body. Near this tree they discovered (although the ground was covered with 3 or 4 inches of snow) one of the meteoric stones, about as large as a man's head, partly imbedded in the earth, and from the circumstances of its position and appearance there could be no reasonable doubt that this was the body which had struck the tree. It is to be hoped that further search will be made for other portions of this meteorite.

The total weight of all the fragments which Mr. Shepherd has brought home is 973 grains. The specific gravity of one of the small fragments is 3.5; but different portions of the stone may vary slightly in this respect, as they may contain more or less of the metallic matter. The resemblance between this meteorite and those of Tennessee, of Georgia, and of Weston, Connecticut, is very close, and one might almost imagine that they were all parts of the same original mass. The cohesion of the stone is not great, as it crumbles under a moderate blow. Two of the fragments retain portions of the crust or exterior coating. This is a fifteenth of an inch thick, and bears evidence of intense ignition and partial fusion. It is black, with a wrinkled or cellular surface, and is traversed with seams. The general color of the interior is an ash-gray. The whole mass is studded with metallic particles, varying from the size of a small shot down to mere points, and presents numerous rusty spots, and occasionally small spheroidal concretions which do not appear to differ in material from other parts of the stone. The little metallic masses, doubtless of nickeliferous iron, are attracted by the magnet, and are generally permeated by the earthy matter. They are mostly of an iron-white color, but several are yellow and slightly iridescent. One of these minute masses being removed from the stone, it was by the hammer at once extended into a thin lamina, and was evidently malleable. An analysis may be expected hereafter.

A study and analysis of the stone were shortly after published by Shepard,[2] as follows:

This specimen was obtained by Mr. Forrest Shepherd, and described by Mr. E. C. Herrick. Mr. Shepherd kindly placed the mass at my disposal, which enables me to extend the account already published by the following notice:

On first inspection the stone appears rather compact and close grained; it is nevertheless composed for about one-half of small imperfectly defined globules of the mineral which has been called meteoric olivine. In color they are light gray, inclining to pearl-gray, and when freshly broken across, show tints of yellow and green. The remaining stony ingredient is white and semidecomposed, resembling the feldspathic mineral in certain trachytic lavas.

Through the whole is sprinkled meteoric iron in shining points, which are often invested with a coating of magnetic iron pyrites. By the aid of a glass a few little black points were discovered of a mineral which appeared to be chrome-iron ore.

Notwithstanding the apparent firmness of the mass, arising out of its close-grained structure, it is still possessed of but little cohesion, since a slight strain of the fingers is sufficient to produce a fracture, even in a rounded-shaped fragment of the stone. When broken in this manner, however, the pieces are not prone to separate still farther, so as to easily give rise to a powder.

The meteoric iron is not tarnished by exposure to the air. It was examined for chlorine, without affording any traces of this element. The most striking peculiarity found in this stone was the small proportion of nickel. At first I failed to detect it altogether, but on a repetition of the search with 8 grains of the alloy, whose nitrohydrochloric solution in a concentrated form was decomposed by ammonia in excess, I noticed an exceedingly faint blue tinge in the fluid. The chromium, however, is more abundant than usual, amounting to above 3 per cent. I did not search for tin or manganese.

The following is a summary of the results obtained:

Silicic acid	31.37	Earthy portion.
Magnesia	25.88	
Protoxide of iron	17.25	
Alumina	.49	
Soda	traces	
Iron	16.00	Meteoric iron.
Cobalt, Chromium	4.28	
Nickel	traces	
Sulphur (phosphorus?) and loss	4.73	
	100.00	

A further account was given by Shepard,[3] as follows:

I have been favored with several additional particulars respecting this fall from persons who reside in the vicinity of the locality.

It fell near a place known as Pine Bluff, on Gasconade River, in township 37, range 11, west of the principal meridian, in Pulaski County. Some persons were abroad in the woods at a sugar camp (a place for making maple sugar),

when their attention was suddenly arrested by a rushing sound, proceeding from a dark-colored body, partially enveloped in smoke, which was moving horizontally through the air, at a distance apparently of only 400 feet above the tops of the trees. They compared its size and shape to those of a blacksmith's bellows, moving with the large end foremost. A bright light or blaze was noticed to hover around the blowpipe extremity of the mass, which vibrated up and down through the space of a few inches. A streak of bright light 100 yards in length followed the blaze. Before there was time to utter a word, the meteor had passed behind a neighboring hill, when a loud explosion ensued. At a place about one mile distant, in the direction of the meteor's passage, two men were at work in a field. They heard the explosion, and saw the stone strike the earth at a distance of 200 yards from where they were standing. It hit the trunk of a tree 18 inches above the ground; and when first discovered seemed enveloped in smoke. (The foregoing statement was supplied by Mr. T. MacDonald.)

The following letter, dated September 12, 1846, describing the phenomenon, is from Mr. B. B. Harrison, a merchant residing in Little Piney, distant about 10 miles from Pine Bluff, where the stone fell. "I recollect the state of the weather on the afternoon of the occurrence. It was perfectly clear and calm. On going out from dinner, I met a man in my door yard who was much alarmed at the sound of a distant cannon, as he supposed, proceeding from a northwesterly direction. On the following day I visited a place 20 miles to the east of this, where the people spoke not only of hearing the same noise, but of seeing a body like a blazing churn pass through the heavens, in a southwesterly direction, the noise, however, proceeding from the northwest. They supposed that something must have fallen from the body within a mile or two of their place. At a place 30 miles farther to the north, the people described the motion of the body as being from the south to the north. I continued traveling about from place to place for several weeks, in the southwestern part of Missouri, and almost every day heard the same object spoken of, although the statements were very discordant in respect to the direction of the meteor. They generally agreed as to the hour of the day. To the citizens of Potosi, which is 80 miles east of this place, the report appeared to proceed from the south.

"After a lapse of some weeks I was presented with a fragment of the stone, which led me to visit the place of its fall. It was at the foot of a hill of very gradual slope, about 0.5 mile from the Gasconade River, 2 miles from the Pine Bluff post office, 10 miles from Little Piney post office, and the same distance from Waynesville. I saw where the stone had struck an oak tree, 18 inches in diameter. The tree was much mangled, though not broken. I saw small particles of the stone still adhering to the tree, and the wood of the tree in the vicinity of the spot where struck, had the appearance of having been burned by gunpowder. The stone was principally carried away, though I was able to procure many pieces, scattered at a distance from the tree. That which I supposed to have been the outside of the stone had a dark brown color, and formed a crust of the thickness of coarse wrapping paper. It had evidently been exposed to intense heat. The injured side of the tree was to the southwest, from which side I was informed that fragments of the stone were projected to a very great distance (three-fourths of a mile).

"Those who first visited the place differ greatly as to the weight of the stone, the estimates varying from 50 to 150 pounds; my own opinion is that it must have weighed at least 50 pounds. The place not being far from the public road, the fragments were soon gathered up by travelers, and have been dispersed very widely through the country. It may be proper to add that I am a native of this place, and that I never saw any other stone resembling the one I send you, here or elsewhere; and that it is quite impossible to account for the injury to the tree, except on the supposition of its being produced by a stone falling from the atmosphere."

The following communication is from M. Frissell, Esq., of Potosi, Missouri, dated March 12, 1842: "The meteor, of which the stone in my possession formed a part, passed in a westerly direction. It must have been large, and I presume that the main body passed on, the piece that fell having formed but a small part of the whole. I did not witness the meteor. Some persons who did compared it to a trumpet in shape, moving with the expanded end foremost. The time of its passage was between 2 and 3 o'clock p. m. Shortly after it had passed the meridian of this place, it exploded with the noise of a heavy piece of ordnance at 2 or 3 miles distant. I was in my office at the time. My first impression was that it was an earthquake. I was soon apprised, however, of what had passed through the air, when I became convinced that the report had proceeded from a meteor. The report was double; like two cannons fired at nearly the same instant, the second being louder than the first. The meteor must have been 20 miles from this place when the explosion took place. I expected that fragments would have been found in this immediate vicinity, but the only one discovered was at Pine Bluff, about 8 miles distant."

The crust of this stone has about the same thickness as that of the Iowa meteorite, though its line of junction with the mass beneath is less perfectly defined. Its color is rather less black, and its surface less smooth and duller. Judging from one specimen in my possession, which exhibits nearly 2 square inches of natural outside, it would appear that its surface must have been marked by very distinct depressions. The color within also resembles that of the Iowa stone. The stone consists of:

Olivinoid	40
Howardite	40
Meteoric iron, Magnetic pyrites	15
Anorthite	5
Apatite	traces
	100

Only about 400 grams of the meteorite are known to be preserved in collections, the British Museum possessing 104 grams.

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Livingston County. See Smithland.

Lockport. See Cambria.

LOCUST GROVE.

Henry County, Georgia.
Latitude 33° 20′ N., longitude 84° 8′ W.
Iron. Nickel-poor ataxite, Siratik Group of Brezina.
Found 1857; mentioned 1895.
Weight, 10½ kgs. (22 lbs.).

The first published mention of this meteorite seems to have been in Brezina's [1] 1895 catalogue. The locality is given as Locust Grove, Henry County, Georgia, and inquiry is made whether the meteorite should be united with the formerly known Henry County, Virginia. Wülfing,[2] accordingly, places the iron in his appendix and makes the same inquiry.

The first description of the meteorite was given by Cohen,[3] as follows:

This meteorite was found on July 29, 1857, near Locust Grove, Henry County, North Carolina, and was preserved until 1895 in a house not far from MacDonough, in Georgia (which circumstance explains Brezina's statement that Locust Grove is in Georgia). The investigation undertaken in the latter year at the instance of the owner determined the meteoric nature of the mass; although the results of this assay seem not to have been published. Since a fiery meteor was observed in the neighborhood of Locust Grove, it has been supposed that this iron fell on that day.

The meteorite was turned over by Mr. Stürtz, in whose possession it had remained, together with the above data, to me for examination.

It is an entire specimen, completely covered with crust; a small piece, estimated at 100 grams, has been cut from one end and is now in the United States National Museum, at Washington. Since the remainder weighs 10,226 grams, the original weight must have been about 10.33 kg.

The mass has the form of a jawbone or, if the irregularities be disregarded, that of a club 24 cm. in length quite evenly truncated at both ends, one of which is 10, the other 6 cm., in thickness. The longitudinal boundaries on three sides consist of a single elongated flat face, the fourth side consisting of two faces which come together at an obtuse angle and form the bulge or projection. Of the three former sides one is 10 cm. in diameter and forms a sort of base upon which the block lies stable. About one-third of this face is covered with numerous small and flat pittings; the second third forms a very large saucerlike depression (8 cm. long, 6 cm. broad, and 2 cm. deep); the last third is smooth. Moreover, a few incisions are observable, which doubtless were produced by a chisel in the effort to cut off pieces of the mass; yet each one may have been caused by casting the mass against sharp pointed fragments of stone. The other two longitudinal faces are 4 and 5 cm. broad; the smaller, which stands almost perpendicular to the larger, is slightly concave and quite smooth; the broader one, which forms an obtuse angle with the former, is quite distinctly concave and thickly covered with small flat pittings. Of the two faces which together form the fourth side of the mass, one stands perpendicular to the base, the other highly concaved face forms with the latter a tolerably sharp angle. The former is rich in distinct and sometimes tolerably deep pittings, while the other shows only indistinct shallow, saucerlike depressions, as if a plastic mass had been lightly pressed with the fingers. The sharp edge shows in some places slight bulges and hooklike protrusions, such as appear on the broken surface of malleable metals. The slightly arched thicker end is thickly covered with pittings, the thinner ends with the cut face above mentioned.

Accordingly, all the faces with exception of the one 4 cm. broad, longitudinal face, and one-third of the base are covered with pittings of similar character; it may be concluded that the meteorite, in its flight through the atmosphere greatly altered its condition. That the form presents scarcely anything characteristic may be seen from a model or photograph of the mass.

The exterior surface shows for the most part a very thin coating of rust; occasionally this is absent and is replaced by a fusion crust about 0.5 mm. in thickness. Its occurrence, as well as the distinct preservation of the finger marks, indicates that no considerable exfoliation of rust could have taken place and that the mass, with the possible exception of the piece cut off, remains in its original form and size. In view of the general condition of preservation it certainly could not have lain long in the damp ground. Despite this fact it seems hazardous to refer the fall to the meteor which was observed a few days before the finding of the mass, since three days is not sufficient for the forming of a coating of rust even as this as that on this meteorite.

If a weakly etched section be observed with the unaided eye, it will be seen that the nickel-iron is composed of irregular grains 0.25 to 0.75 mm. in size, of which the larger number also show a shimmering reflection, as well as thin, long lamellæ and small, brightly glistening rhabdites. If a stronger magnifying power be used, tiny lumpy eminences appear in very large numbers, which hinders the recognition of the finer structure of the above-mentioned grains.

The little lumps are oval to round. In the former case, they have a diameter of 0.01 to 0.02 mm.; in the latter case they attain a similar thickness and a length of 0.04 mm. They lie close together and are quite evenly distributed, so that the interspaces as a rule are only 0.02 to 0.05 mm. in size and vary but slightly from these dimensions; the etched section is therefore regualrly compacted and fine grained. Only in the neighborhood of the lamellæ and the rhabdite do the lumps diminish in number, and when the former cluster together in larger numbers the lumps disappear entirely in their immediate neighborhood. On such places a smooth etching zone appears distinct from the rest of the iron mass. These tiny formations suggest somewhat crystals of schreibersite or cohenite, which are not so readily affected by etching as nickel-iron. However, they can not be isolated by dilute hydrochloric acid nor by copper ammonium chloride, and the quantity of phosphorus and carbon found is far from sufficient for such an interpretation. Alloys rich in nickel, moreover, according to the results of the analysis, are not present.

The above-mentioned lamellæ attain a length of 13 mm. and a thickness of 0.02 mm.; they are apparently irregularly oriented, and when they occur scattered everywhere, they still readily mass themselves in greater numbers in some places. By treating the nickel-iron with dilute hydrochloric acid they still are not isolated; small, deep grooves quickly appear, but the residue contains no flakes. On the other hand, after dissolving in copper ammonium chloride, there remain, besides carbonaceous substances, tin-white, very brittle, thin scales, which, after dissolving in aqua regia, give a strong phosphorus reaction, so that without doubt scales of schreibersite are present. They are distinguished from similar occurrences by less thickness and more frequent occurrence.

Rhabdite occurs in considerable quantity and is sometimes found isolated, sometimes in small groups. In the latter case, the rhabdites are sometimes oriented perpendicular to one another, so as to form a fine network with rectangular meshes; the majority are, however, irregularly arranged. In one place small needlets arrange themselves around the end of a larger needle, so as to form a very beautiful star-shaped group. The rhabdite attains a length of 3 mm. and a thickness of 0.25 mm., but as a rule falls well within these dimensions and is for the most part of a compact form. Schreibersite can be isolated from them. A few spots occur consisting of quite irregular particles of schreibersite of about 1 mm. in size, closely filled with tiny dark grains; they resemble those which lie in such large numbers in the nickel-iron.

Graphite and troilite nodules occur only in isolation and of small size. A graphite nodule 10 mm. long and 5 mm. wide is still present entire; a second nodule of about the same size and of a pear-shaped form has fallen out in the cutting of the plate or section, except for a small remainder clinging to the wall of the cavity. After these come a few small elongated particles (8 to 9 mm. long, 1 to 2 mm. wide). The troilite forms round particles of a few millimeters in size, a few of which are entirely or partially bordered with schreibersite.

In the four sections examined all the graphite and troilite nodules as well as most of the schreibersite lamellæ lie in proximity to the original surface of the meteorite, while the central portion contains rhabdite almost exclusively. It may be noted in this connection that iron sulphide is also found separated on the surface of pig iron rich in sulphur.

As the sections of the two ends of the billet-shaped mass have been separated from one another as far as possible before now, and as the section surfaces together measuring 160 sq. cm. show exactly the same character, it may be assumed that the meteorite has the same structure throughout. Nothing of any importance can be gathered from the alteration zone near the fusion crust.

The insoluble residue contains a small quantity of grains which, when entirely separated have a diameter as great as 0.1 mm., but for the most part are of only 0.02 to 0.03 mm. and sometimes very much smaller. By far the greater number belong to the colorless grains with high cleavage exponents and sometimes stronger, sometimes weaker double refraction, which have been found hitherto in every meteoric iron which has been investigated in this direction. Many of them harbor numerous tiny opaque inclusions. Quartzlike grains having the same index of refraction as canada balsam are much less numerous here than usual. A few, small, columnar microlites, rounded at the ends, with very strong relief and very lively interference colors, resemble in a high degree many zircon microlites of terrestrial rocks. In addition to these there are isolated blue, pleochroic obliquely extinguishing columnar fragments, brown grains having a double cleavage, as well as splinters, each one of which according to its position is either cinnamon-brown or almost black and appears comparable with tourmaline in respect to coloring and absorption. The intermingled opaque particles are more probably slow burning carbon than chromium, since a chrome reaction was not obtained.

Analysis (Sjöström), specific gravity by Leick, 7.7083:

Fe	Ni	Co	Cu	C	O	P	Cl	
94.30	5.57	0.64	trace	0.02	0.05	0.18	0.01	=100.77

Mineralogical composition:

Nickel-iron	98.70
Schreibersite	1.16
Troilite	0.12
Lawrencite	0.02
	100.00

Locust Grove belongs to the granular ataxites, that is, to those meteoric irons of a granular structure, in which the individual grains show neither a structure of octahedral lamellæ nor intercalated twin lamellæ. The nickel-iron, according to its chemical composition, belongs to kamacite. Of known meteorites Siratik is perhaps the nearest, since in it also appear upon a spotted groundmass glistening stripes irregularly crossing each other.

Later, Cohen [4] corrected the statement that Henry County was in North Carolina, and placed it properly in Georgia.

The meteorite is distributed. Vienna has 381 grams, Chicago 370 grams, the British Museum 365 grams.

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LONACONING.[a]

Alleghany County, Maryland.
Latitude 39° 35′ N., longitude 78° 38′ W.
Iron. Coarse octahedrite (Og), of Brezina.
Found 1882; described 1892.
Weight, 1,260 grams (45 ozs.).

This meteorite was described chiefly by Foote,[1] as follows:

A physician residing near the Maryland line of Pennsylvania recently brought to me an iron mass to learn if it was meteoric, and this it proved to be. It was discovered in Garrett County, Maryland, about 12 miles from the post office of Lonaconing, not far from the boundary. It was ploughed up about three or four years ago by a boy in the field. According to an analysis by Dr. Koenig it contains over 11 per cent of nickel and cobalt, the proportion of cobalt being unusually high. It is one of the best octahedral etching irons known, being even more characteristic than most of those that have been used for printing directly on paper. Besides the striking reticulated octahedral structure, it shows a large number of secondary lines regularly disposed with reference to the principal markings. These I believe to be similar to those described by Prof. J. Lawrence Smith, in a Wisconsin meteorite, under the name of Laphamite markings. The original weight was 45 ounces, but it has been reduced by analysis, cutting, polishing, etc., to 36.5 ounces.

The iron was described by Brezina [2] as follows:

An iron of 1.2 kg. weight, in the form of an elliptical cylinder with slightly bent axis. The section shows along the natural surfaces a finely flecked zone of alteration 2 to 9 mm. thick. The lamellæ are puffy, tænite well developed, fields predominant, almost entirely filled with a repetition of systems of combs running in many different directions in the same; field less frequently filled with a dark gray plessite. Two large plessite areas show finely shimmering central skeletons. Cohenite grains sometimes occur isolated in the kamacite. The kamacite bands are slightly granular, the kamacite combs much so.

The meteorite is distributed, the largest quantity (819 grams) being in the Paris School of Mines collection.

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LONG ISLAND.

Phillips County, Kansas.
Here also Phillips County.
Latitude 39° 45′ N., longitude 99° 25′ W.
Stone. Veined intermediate chondrite (Cia), of Brezina; Erxlebenite (type 34) of Meunier.
Found 1891; described 1895.
Weight, 564 kgs. (1,244 lbs)..

This meteorite was classified by Brezina [1] in 1895 as a crystalline chondrite (Ck). The same year Weinschenk [2] gave a petrographic description, as follows:

From the Long Island, Phillips County, Kansas, occurrence I have at my disposal four pieces, amounting in weight to 20–30 grams. They possess a rusty weathered surface. Many hundred similar pieces were found (in part with

[a] The locality is usually given as Lonaconing, Garrett County. The meteorite was found, according to Foote, in Garrett County, but Lonaconing is in Alleghany County.

crust), having a total weight of 1,184 pounds. The meteorite of Long Island is a compact, dark stone which appears dark green on fresh fracture and shows numerous metallic specks. The crystalline structure is megascopically visible; there are numerous shining cleavage surfaces and the meteorite resembles the fine-grained harzburgite from Riddles, Oregon. Chondri are only now and then to be seen. Under the microscope it is clearly seen that chrysolite and bronzite are the characteristic ingredients. The structure as well as the relations in quantity of the two constituents are very variable, the chrysolite now being in excess and now again the pyroxene, and the general porphyritic structure passes commonly enough over to a purely granular one. Chondruslike forms are found throughout, but they are seldom developed in an especially characteristic way. Ragged particles of metallic iron, numerous grains of iron sulphide (troilite?), and chromite complete its composition. The chrysolite occurs generally in porphyritic, more or less idiomorphic crystals, and in fragments. In the fresh condition it is colorless, but on slight heating it becomes reddish brown and pleochroic, and at red heat completely opaque, indicating a high content of iron. The cleavage of the mineral is always clearly developed, and this shows in many cases undulatory extinction. It is very rich in inclusions, generally appearing as dark-brown rounded forms which often show regular arrangement. In the weathered portions there occurs, besides iron hydroxide, a serpentinelike substance as an alteration product of the chrysolite. The orthorhombic pyroxene is likewise colorless and transparent and may be classed as bronzite. It tends to form groups of larger individuals where the stone has granular structure; in smaller crystals it occurs also as a constituent of the groundmass in the porphyritic forms. Its distribution in the stone can best be seen if a section is treated with hydrochloric acid. This dissolves out the chrysolite but leaves the pyroxene unattacked. In sections so treated it can especially well be seen that the bronzite where it occurs as a constituent of the groundmass often exhibits skeleton growths which lie embedded in a colorless substance and are not attacked by hydrochloric acid. This has weak refraction and between crossed nicols shows irregular illumination, so that it is not improbable that it is a glassy substance possessing optical anomalies through strains. Rarely, besides the orthorhombic pyroxene there is to be seen a monoclinic augite in single grains, with the properties of diallage. The solid iron occurs in angular particles and often in zonal growths with chromite, which also occurs alone, widely distributed in the stone. The little grains of the latter mineral appear brown, translucent. Also pyrrhotite (*magnetkies*) is present in considerable quantity and generally in large individuals. The structure of the whole stone indicates a cooling from a fused liquid, a view also supported by the porphyritic crystals of chrysolite and the skeletons of bronzite in the colorless base. There is no trace of breccia structure and the occurrence of few well-defined chondri gives no further proof. As has been often observed in meteorites, the whole stone has much more the character of a suddenly cooled mass, a character which is also indicated by the undulatory extinction of the chrysolite, the skeleton growths of pyroxene, and the sudden variations in composition. The Long Island meteorite in mineralogical character belongs to the harzburgites. If among terrestrial rocks we look for masses which in a structural and mineralogical way can be compared to the Long Island meteorite, it will be found that the number is a very limited one for the reason that rocks of similar composition have suffered in most cases much decomposition, by which their structure becomes indeterminable. But, at all events, it seems probable from the few observations on, for example, the terrestrial basalts of Greenland, that similar structures as they are here observed, and in many other meteorites are formations characteristic of cooled rocks in which silicate of magnesia plays an important part, and that no grounds are given for the belief that formations of this kind in any of the terrestrial rocks have originated in any different way.

In 1902 a full description of the meteorite was given by Farrington,[3] as follows:

Nearly all of this great meteorite is possessed by the Field Museum and this has been the case since the opening of the institution in June, 1894, but it has never been fully described. A few lines were devoted to the meteorite and a cut of it shown in the catalogue of the meteorite collection published in August, 1895. A petrographic description from frgaments of the stone was also given by E. Weinschenk in 1895.

No account of the finding of the stone seems ever to have been published, however, and there are many other features which are well worthy of description. For details regarding the occurrence of the stone I am indebted to Professor Williston, of the University of Kansas, and Professor Willard, of the Kansas Agricultural College. Professor Williston states that a fragment of the meteorite first reached him in the fall of 1892. Professor Willard secured one at about the same time. On recognizing the meteoritic nature of the fragments sent them, Professors Williston and Willard at once entered upon negotiations for the purchase of the mass and soon became its possessors. The work of collecting the pieces at the original locality was done by Professor Willard, and to him I am indebted for information regarding the occurrence there.

The meteorite lay, he states, on a slope of the ordinary soil of the upland prairie region. There is no outcrop of rock in the immediate vicinity and none within several miles, so far as he knows. Where there is an outcrop the rock is limestone. The distribution of the pieces of the meteorite as first seen by Professor Willard was such as to indicate that the mass had struck upon a slope and, its front portion being stopped, the rear portion had broken up and gone ahead. The four large pieces, which are put together to make the mass shown in a cut, were together and in contact at the upper end of the fall. The top of these projected about 4 inches above the soil and the lowest point to which they reached was perhaps 2 feet below the surface. Beside these large pieces a quantity of smaller fragments more or less embedded in the ground extended down the slope in a northwest direction for a distance of from 15 to 20 feet in a gourd-shaped area which was perhaps 6 feet wide at the widest point. The location of the spot where the meteorite was found is about 3 miles west of the present town of Long Island, 0.5 mile east of the west line of

Phillips County, and 3 miles south of the Kansas-Nebraska State line. It is from the neighboring town of Long Island that the meteorite takes its name. With regard to the time of the fall no knowledge has yet been obtained. The stone was noticed by early comers to the region and was generally reputed to be a meteorite, so that visitors had in many cases taken away pieces as curiosities. That the mass had lain a number of years in place is proved by the coating of carbonate of lime, in some places 2 or 3 mm. in thickness, which incrusts many of the pieces. Further evidence of the long exposure of the stone is given by the weathered character and rusty brown color of the surface of exposed fragments of the stone in contrast to the dark green color of their interior. The meteorite as collected by Professor Willard was shortly afterwards purchased by Mr. George F. Kunz, of New York City, and after remaining in his possession for about a year was secured for the Field Museum.

The entire weight of the meteorite as received at the museum and made up of 4 large and 2,930 small fragments, was 1,184 pounds (537 kg.). This was supposed at the time to be the entire weight of the mass, but a year or two later Mr. Kunz obtained about 60 pounds (27 kg.) more, which is for the most part still in his possession. This additional material was chiefly fragments obtained from people in the region who had carried off portions of the stone for curiosities. A weight of at least 1,244 pounds (564 kg.) can therefore be positively assigned the stone, and there is little doubt that it originally weighed somewhat more than this, since some pieces were probably carried off that will never be recovered. That the fragments all belonged to a single mass the manner of their occurrence in place leaves no doubt. Moreover, their edges show no rounding or fusing, as would have been the case had any of them made an independent passage through any considerable part of the earth's atmosphere. The stone is therefore much the largest single-stone meteorite known to exist, its nearest competitors being the Bjurböle meteorite, which weighs 748 pounds (340 kg.), and one of the stones of the Knyahinya fall, which weighs 649 pounds (295 kg.).

As soon as the installation of the stone was undertaken at the museum, it was at once seen that the four large pieces fitted together. Doubtless others of the fragments could be added to these, but as an effort to do this proved on trial to be likely to consume considerable time without giving any important results, the attempt was abandoned. There would be more hope of success if the museum possessed the entire mass of the stone, but as it is, many of the fragments would be missing at best. The four large pieces weigh together 669 pounds (303 kg.), or more than half the weight of the stone. They hence probably give its essential form. Their weights are 269, 239, 89.5, and 71.5 pounds (122, 108, 46, and 32 kg.), respectively. The largest of the remaining fragments at the museum weighs 22.25 pounds (10 kg.), which is a weight much below that of the smallest of the four large ones. Mr. Kunz informs me that one of the fragments in his possession weighs about 35 pounds (15.8 kg.). The smaller fragments range from the weight above mentioned to those not over a gram in weight. Some have the true meteorite crust on one surface, showing that they are from the superficial portion of the stone, while the rough, irregular surfaces of the remaining fragments show that they were wholly within the interior. * * * A considerable portion of the restored mass has an almost wholly natural surface; over this portion, therefore, the actual form of the stone is preserved. The form of the stone as at present restored is, as shown by a plate, roughly that of a low cone. The greatest diameter of the base of the cone is 34 inches (86 cm.) and the altitude from base to apex 20 inches (51 cm.). The conical form, as is well known, is the typical one to which meteorites are reduced in their passage through the atmosphere, from the fact that the portion of the mass in front, receiving the brunt of the friction and heat, is worn down rapidly to an apex from which the other portions slope away. That this is the position which the Long Island stone took in falling is further indicated by the smooth, unpitted character of the base of the cone (*Rückseite*) as compared with the pitted surface of the conical portion, and further by the fact that the series of pittings (*piezoglypten*) on the surface extend in radial directions from the apex of the cone. It will be noted, in a plate, that the long axes of the pits run in directions nearly parallel to lines drawn from the apex to the base of the cone. These, then, were the directions of the air currents. The planes along which the four large fragments were separated and along which they have now been joined together are not courses of ordinary irregular fracture, but are definite divisive planes. There are three of these planes, two being continuous each in its own direction while the third may be described as made up of two planes meeting at a very broad angle (160°). The planes run in three directions nearly at right angles to each other. They meet, but only at one point do they pass through one another. If one will conceive of an apple cut in halves by a plane starting a little to one side of the bloom, one of these halves then cut through equatorially in a direction at right angles to the first plane by two planes starting a little above the equator, but meeting at it, then the quarter nearest the bloom cut through by a plane at right angles to the equatorial plane in a direction running from the bloom to the stem and passing into the otherwise uncut half for quite a distance, an idea will be gained of the course of the division planes of this meteorite.

The area of each plane is approximately as follows: Plane A=200 sq. in. (13 sq. dm.); plane B=196 sq. in. (12 sq. dm.); and plane C=113 sq. in. (7.1 sq. dm.).

The position of these planes makes it unlikely that they were developed by the blow of the meteorite in striking the earth, for one at least runs nearly at right angles to the probable direction of motion of the meteorite. Further, as stated more in detail below, the striæ of the slickensided surfaces run in different directions.

Plane A runs quite nearly in the direction of probable motion and it is interesting to note that near each end of the meteorite irregular cracks appear which are approximately parallel to this plane. Their position suggests that they may have been produced by the tendency of the base of the meteorite to continue its motion after the apex had been stopped by striking the earth. Plane C, separating pieces 2 and 4, can be noted continuing on in piece 1 as a line which extends nearly to the edge of that piece. This portion of the plane evidently was not sufficiently developed as a division plane to produce disruption of the piece when the meteorite struck the earth.

That the three planes described represent a structure which existed in the meteorite before its entry into the earth's atmosphere there can be little doubt. They are too regular to make it possible to consider them planes arising from fracture by shock and there are several other lines of evidence pointing to their preterrestrial existence. The most important of these is that their surfaces are slickensided. The slickensided character of the surface resembles that seen in terrestrial rocks, and is illustrated in a figure. It is a smooth, shining, somewhat undulatory, like a *roche moutonnée* surface, and bears short striæ which on the same surface run in one general direction, but take different directions on the three several planes. These several directions are indicated in a figure, where one of the fragments is represented as removed. The color of the slickensided surfaces is somewhat darker than that of the crust of the meteorite, but there is no evidence of special heat having been developed by the force which produced the slickensides. This I have tested by cutting sections at right angles to the surfaces. The outlines of the individual grains were found to be sharp and unaltered up to the slickensided edge.

Since slickensided surfaces on terrestrial rocks are, so far as known, produced by slow differential movement in the mass under considerable pressure and while in the solid state, they may in the absence of any evidence to the contrary be assigned to the same cause in this meteorite. The conclusion seems fair therefore that these planes and surfaces were formed during the preterrestrial existence of the mass and that the mass must have been solid in its nature while in space. The three planes which I have described seem to me to resemble the joint planes of terrestrial rocks more than anything else I can think of and give us grounds for asserting the existence of joint structure in the rocks of of space. I do not know that well-marked joint structure has been observed in any other meteorites except that noted by Meunier in one of the stones of L'Aigle. This stone he regarded as possessing a joint fissure, but it was not as well developed as the planes of the Long Island stone.

If the occurrence of joint structure in the Long Island stone is deemed proved, it is significant as pointing to a considerable mass possessed by the body in space. Joint blocks of such size as this would not be likely to be developed in a small body.

The natural surface of the more conical part (*Brustseite*) of the meteorite as it is at present joined together, is for the most part deeply pitted with characteristic meteoritic thumb-marks (*piezoglypten*). These pits vary considerably, as would be expected, in form and size, but still exhibit a certain uniformity. The majority have the form of an elongated ellipse whose major axis is about twice the length of its minor. The following dimensions may be considered as representing a fair average of the size of the pits: Major axis, 3.2 cm. (1.25 in.); minor axis, 1.5 cm. ($\frac{5}{8}$ in.); depth, 3 to 10 mm. ($\frac{1}{8}$ to $\frac{3}{8}$ in.). The depression of each pit generally slopes uniformly toward the center of the ellipse, but often there are to be found pits, the deepest point of which is quite eccentrically placed and which have a more or less conical shape. Some pits have a nearly circular outline as contrasted with the more common ellipsoidal one. These circular pits are usually of small size, but one of large size and unusual depth is to be found at the point in the meteorite where the two planes A and C cut each other. This pit has for the most part the shape of a deep regular bowl, although the regularity of one portion is broken by two smaller conical pits. The depth of this pit is 3.2 cm. (1.25 in.) and its diameter 6.4 cm. (2.5 in.). The point of junction of the planes is almost exactly at the center of the pit. It is evident that this was a point of weakness in the stone at which the erosive action of heat and friction produced during the passage of the mass through the atmosphere worked more rapidly than on other parts of the surface. Its occurrence at the point of junction of the planes is pretty good evidence that the latter existed in the stone previous to its entry into the atmosphere. This fact has also a bearing on the disputed question as to the origin of the pits in general. It shows that they owe their origin chiefly to an excavation by heat and pressure of the softer or more friable parts of the surface of the mass which is acted upon. Wherever there is a point of weakness there a pit will be formed. Vice versa, where a pit is formed, there was a point of weakness.

The rear side (*Rückseite*) of the stone is not pitted. It has a well-developed crust, but the encrusted surface exhibits no marked depressions or elevations. The only portion of the meteorite as now restored which illustrates the *Rückseite* is that appearing in the upper right-hand part of an accompanying plate. Here the surface is slightly undulating, but there are no pits.

The color of the crust of the meteorite is in general dark brown, but varies from almost black to light brown. At a little distance it appears perfectly smooth and in places shining, but on close examination it is seen to be quite uniformly and coarsely stippled by the protrusion of the more resistant grains. In many places, especially in the vicinity of the pits, minute threadlike markings appear over the surface, sometimes in parallel and concentric series, but more commonly in arborescent forms which are often quite elaborate. These series or systems of markings do not appear to run in any common direction, but are differently oriented wherever found. I have noted no system more than 1 inch (2.5 cm.) in length, but several of about this extent. They resemble closely the lines of flow such as have been noted on the crust of the Stannern and other meteorites, and doubtless are of this nature, being formed by a minute portion of the substance of the meteorite becoming momentarily fused and flowing in a diversified path until cooled. Their course in some cases seems to mark the swirling of the same air currents which formed the pits. More extensive and larger ridges are to be observed over some portions of the crust. Three nearly parallel appear on the portion of the *Rückseite* just mentioned. Each is continuous for a length of from 3 to 5 inches. These do not appear to be of the nature of the lines of flow above mentioned, but more nearly resemble the veins which stand out on some meteorites and probably mark a line of more highly resistant constituents. Sections cut at right angles to the crust and examined with the microscope exhibit little if any alteration on the crust surface. The mineral outlines seem to be continued sharply up to the edge, and except for a certain smoothness of contour a crust surface could not be distinguished microscopically from the surface of an interior portion. Occasionally a metallic grain protrudes from the general outline, but so far as the contour as a whole is concerned it appears to be the result of erosion rather than of fusion.

The weathering which the mass has undergone since its advent upon the earth has affected it considerably. Even the larger fragments when broken open will be found to be deeply invaded by rust which has penetrated along cracks in every direction. Doubtless the great number of small fragments into which the stone was found to be broken when first discovered was due to this process of separation through weathering rather than to shattering caused by the blow of the mass upon the earth. The weathering has affected chiefly the metallic constituents of the stone, causing their oxidation, and this rust has penetrated and stained the meteorite deeply. The color of the weathered surfaces has thus been changed from the dark green of the unaltered rock to various shades of brown, a characteristic color being a light yellowish-brown, almost white, spotted with dark or rust brown.

The depth to which this discoloration has extended, except where it has followed cracks and fissures, is usually scarcely a millimeter, the color changing beyond this through reddish to black before the dark green of the unstained stone is seen.

Over a large part of the surface of the stone as found appeared a white amorphous coating which adhered very firmly. It could be removed by treatment with weak acid, and most of it has been taken off in this way since the arrival of the stone at the museum. When its substance is examined chemically it is found to be carbonate of lime containing a small percentage of clay. There can be little doubt that this coating is derived from the calcareous soil in which the stone lay for an unknown period, the carbonate of lime from the soil doubtless spreading over the meteorite surfaces through capillary attraction and cementing upon the stone some of the surrounding clay. In some cavities of the stone a much greater proportion of soil is held, and at many points the cementing agent is iron oxide, derived doubtless from the oxidation of the metallic grains of the meteorite.

The unaltered stone, when exposed by fresh fracture, is of a dark-green color, varying to black, although the latter shade may be due to staining from terrestrial oxidation. The stone is fine grained, tough, and compact. Occasional portions exhibit a slight porosity, giving a slaglike appearance. Such areas are, however, small and the pores of small size. The proportion of metallic ingredients is not large but they are quite uniformly distributed.

The metallic grains show most plainly on a polished surface, the distribution and quantity being illustrated in a figure. Occasionally well-marked aggregations of these may be seen. None of the surfaces that I have examined show arrangement of the grains in lines or systems of lines such as have been noted in a number of stone meteorites by Reichenbach and Newton. The largest metallic grain I have seen in the Long Island meteorite has a diameter of 1.5 mm. From this size all gradations may be found down to the minutest grains, examination with a lens bringing out many not visible to the naked eye.

The bronze-yellow color and comparative softness of many of the grains as exhibited on a polished surface mark them as troilite, in contrast to the silver-white color and greater hardness of those composed of nickel-iron. Further identification of the grains can be obtained by isolating them or by treating a polished surface of the meteorite with copper sulphate. On the polished surfaces examined the number of troilite grains is evidently much in excess of those of nickel-iron. As individual grains they are, however, smaller in size. Often the nickel-iron and troilite can be seen to be intergrown in a single grain.

Before the blowpipe a fragment of the rock fuses, even in the oxidizing flame, with a fusibility of about 4.5, the entire fragment blackening from the formation doubtless of FeO. In the reducing flame the fusibility is, as would be expected, greater on account of a more rapid formation of FeO. Evidently the mixture of minerals forms an aggregate fusible at a lower temperature than any of its components, for the component minerals are practically infusible.

The specific gravity of the stone, determined as an average of three separate portions weighing 50, 18, and 7 grams, respectively, is 3.45.

To the observations of Weinschenk [regarding the petrographic characters of the meteorite] there is little of importance to be added. The crystalline structure is perhaps hardly as prominent megascopically as one would judge from Weinschenk's account, while the chondritic structure is easily recognized in all the sections I have examined. There are numerous polysomatic porphyritic chrysolite chondri and typical fibrous ones of enstatite. One of the latter observed was 2.5 mm. in diameter, and it is evidently not cut through its center. A black, seemingly carbonaceous matter borders its outer edge. The fibers are minute and lie in parallel groups extending in various directions. A porphyritic chrysolite chondrus seen had a diameter of 1.25 mm., a single grain reaching the size of 0.025 mm. Another monosomatic chrysolite chondrus seen was made up of chrysolite porphyritically developed in glass and with a distinct circular border of chrysolite all extinguishing simultaneously. This chondrus also contained a large grain of troilite. The crystal outlines of the chrysolite individuals, whether developed in the chondri or out, are often well defined, the predominant habit being short stout crystals bounded chiefly by pinacoids. The chromite more often has a red tone than the brown described by Weinschenk, its deep red grains being frequently seen in the sections. Both nickel-iron and troilite grains sometimes inclose small siliceous particles of what is probably chrysolite, indicating the latter to be the earlier formation.

As regards classification, the Long Island meteorite is classed by Wülfing as a crystalline spherical chondrite, Cck. Beaver Creek, Bethlehem, Lumpkin, Menow, Prairie Dog Creek, Richmond, and Savtschenskoje are other meteorites included in the same class.

Brezina classifies Long Island as a crystalline chondrite Ck., in which group are included Erxleben, Klein-Wenden, Kernouve, and many others. By Meunier, Long Island is put in class 34, Erxlebenite, which includes monogenic meteorites of fine grain made up chiefly of chrysolite and bronzite and containing visible grains of nickel-iron. Bluff, Erxleben, Kernouve, Klein-Wenden, Menow, and Pipe Creek are among the other meteorites brought by Meunier into this class. Thus the place of Long Island in classification seems to be quite generally agreed upon. Differences

can, of course, be noted from other meteorites with which it is classed, it being, for instance, more compact and of finer grain than Beaver Creek and containing much less nickel-iron than Pipe Creek.

Of its well-marked crystalline character, however, there can be no doubt, nor, to my mind, of its monogenic origin.

Absorption by a siliceous magma, of iron in preference to nickel, seems to me to afford a reasonable explanation of the high percentage of nickel in the metallic portion of the stone shown in the following analysis. Such a high percentage of nickel in the nickel-iron of stone as compared with iron meteorites is common and must be of some significance. If the meteorite is simply tuffaceous in origin, one would expect the nickel-iron to have the composition of that of the iron meteorites uninfluenced by the accompanying silicates, but such is not the case.

Again, the outlines of the crystal individuals in the Long Island meteorite are sharply and fully developed and are in stable and magmatic position with reference to each other. Some of them are larger than the individual chondri and yet exhibit no sign of wear or fracture. Accordingly the believers in the tuffaceous character of all stone meteorites would find, I think, little to support their views in an examination of this stone. I can see no indications in its structure of any other origin than one of cooling in place from a fused magma.

An analysis of the meteorite was made by Mr. H. W. Nichols, as follows:

	Metallic.	Sol. in HCl.	Insoluble.	Total.
SiO_2		9.11	26.54	35.65
Al_2O_3		1.64	1.44	3.08
FeO		17.19	5.66	22.85
MgO		8.99	13.75	22.74
CaO		0.02	1.38	1.40
Na_2O		0.00	0.25	0.25
K_2O		0.00	0.03	0.03
H_2O above 100°		1.52	.....	1.52
TiO_2		.....	trace	trace
P		0.036	0.024	0.060
S		1.900	.....	1.900
Cr_2O_3		0.34	5.99	6.33
NiO		0.089	0.68	0.769
CoO		0.013	0.047	0.060
MnO		trace	.....	trace
Fe	2.60	.....	.....	2.60
Ni	0.67	.....	.....	0.67
Co	0.036	.....	.....	0.036
O for Limonite		0.90	.....	0.90
	3.31	41.75	55.79	100.85
Less O=S		0.95	.....	0.95
Less O=P		0.06	0.04	0.10
	3.31	40.74	55.75	99.80

The most striking feature of the composition revealed by this analysis is the high percentage of Cr_2O_3. I know of no other meteorite which shows so high a percentage, more than 1 per cent being rare. Most of this was found in the insoluble portion and may hence be referred to chromite, especially as examination of sections with the microscope shows a large quantity of the red translucent grains which indicate that mineral. It may be worthy of remark, however, that the chromium mineral of the meteorite was more easily decomposed than ordinary chromite. Although left as an insoluble residue after fusion with sodium carbonate, it went into solution on treatment with sulphuric acid without requiring a separate fusion with acid sulphate of potash. The percentage of Cr_2O_3 noted in the soluble portion of the meteorite may probably be regarded as a constituent of the chrysolite, although its quantity here is above the average.

The quantity of Al_2O_3, shown in the soluble portion of the above analysis, is unusually high and is difficult to account for, although it has not infrequently been reported by other analysts as a constituent of the soluble portion of meteorites.

Grouping the compounds of the above analysis which are known to enter into the composition of nickel-iron, chrysolite, and bronzite, the following may be deduced as the probable composition of these three ingredients:

COMPOSITION OF NICKEL-IRON.

Fe	78.65
Ni	20.26
Co	1.09
	100.00

COMPOSITION OF SOLUBLE SILICATES (CHIEFLY CHRYSOLITE).

SiO_2	36.88
MgO	36.40
FeO	18.62
Al_2O_3	6.64
Cr_2O_3	1.38
CaO	0.08
	100.00

Ratio of $2RO:SiO_2::1.9997:1$.

COMPOSITION OF INSOLUBLE SILICATES (CHIEFLY BRONZITE AND MONOCLINIC PYROXENES).

SiO_2	56.52
Al_2O_3	3.07
FeO	6.05
MgO	29.28
CaO	2.94
CoO	0.10
NiO	1.45
Na_2O	0.53
K_2O	0.06
	100.00

Ratio of $RO:SiO_2::1:1.0148$.

To place the alkalies in the pyroxenes, as is here done, is contrary to the usual custom, it being common to assume that they are present as feldspars. But as no feldspars could be detected in the slides and as alkalies are known to enter into the composition of pyroxenes in small amount, the conclusion here adopted seems the more reasonable one. No attempt was made to differentiate the two pyroxenes chemically, as I know of no guide for this. The amount of monoclinic pyroxene which can be seen in sections is very small, so that the above can practically be regarded as bronzite. It may seriously be questioned, however, whether digestion in hydrochloric acid can be relied upon to wholly separate the chrysolite and bronzite, for with longer digestion some of the bronzite is apt to go into solution, or, with shorter treatment, some of the chrysolite may not be decomposed. Further investigation of this subject should be made.

Taking all the probable ingredient minerals of the rock into consideration, the following is perhaps the best estimate that can at present be made as to its probable composition:

Bronzite and monoclinic pyroxenes	47.05
Chrysolite	24.74
Limonite	10.50
Chromite	8.83
Troilite	5.24
Schreibersite	0.23
Nickel-iron	3.31
Oxides of cobalt and nickel	0.10
	100.00

Here the limonite is probably of secondary or terrestrial origin and should perhaps be divided up about equally between the nickel-iron and troilite in estimating the preterrestrial composition of the rock. The composition as shown above of about one-half bronzite accords well with what one can observe after treating a section with hydrochloric acid so as to dissolve out the chrysolite, for an extensive framework made up of bronzite then remains. The high percentage of chromite indicated by the analysis is also in accordance with observations made with the microscope.

The resemblance of the meteorite to terrestrial peridotites is, as noted by Weinschenk, very marked, and the constant association both in terrestrial and extraterrestrial regions of the elements and minerals which compose rocks of this class indicates laws of association which are not yet comprehended.

Brezina [4] in 1904 changed his classification of the meteorite to veined intermediate chondrite (Cia).

The meteorite is distributed but the larger part is in the Field Museum collection.

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Los Angeles. See Shingle Springs.

LOS REYES.

Mexico D. F., Mexico.
Latitude 19° 10′ N., longitude 98° 50′ W.
Iron. Medium octahedrite (Om). of Brezina.
Found 1897; described 1902.
Weight, 19.5 kgs. (43 lbs.).

This meteorite was described by Farrington,[1] who regarded it as probably a member of the Toluca fall. Studies made in connection with this catalogue, however, make it seem probable that it should be considered an independent fall. Farrington's account is as follows:

This meteorite was obtained for the museum in the spring of 1897 from Mr. E. O. Matthews of the City of Mexico. It was brought him by some native Mexicans or peons who reported that they had found it some months before at Los Reyes while plowing. This is all the evidence obtainable regarding the manner of its discovery. The meteorite is of the metallic variety (aërosiderite) and is a complete individual. Its weight entire is 43 pounds (19.5 kg.). Its form (illustrated by cuts) is roughly that of a steep triangular pyramid whose greatest length is 24 cm. (9.5 inches), and greatest width 15 cm. (6 inches). The sides of the pyramid are deeply hollowed and rounded so that the contours of the mass are curved, and at one of the edges it extends out in the form of a thin wing. On one side near the base are two especially deep and well-marked pits side by side, one somewhat conical in shape, the other broadly concave, The diameter of the conical pit is about 45 mm. (1.75 inches) and its depth 20 mm. (0.75 inch). The concave pit is about 63 mm. (2.5 inches) in diameter and 12 mm. (0.5 inch) deep. These pits probably mark areas of schreibersite which were fused out during the passage of the meteorite to the earth. The surface of the meteorite is of a uniform dark brown color from oxidation, but the depth to which oxidation has penetrated is very slight, as the merest scratch with a file reveals the nickel-white color of the interior. The meteorite is not of the "sweating" variety and exhibits no tendency to further alteration.

Its substance is tough and malleable to a high degree. It is medium hard, cutting with some difficulty with a hack saw. It takes a good polish, a polished surface being of silver-white to nickel-white color. Relative to copper sulphate the meteorite is active.

The iron has not been sliced, but a triangular area 63 mm. by 25 mm. (2.5 inches by 1 inch) was made smooth and etched with nitric acid. The surface etched easily and exhibited well-marked Widmanstätten figures. Two other smaller surfaces were also etched on other portions of the meteorite. The figures of the meteorite show that it is to be classed with Brezina's group 46 (octahedrite with lamellæ of medium width) or Meunier's group 7 (arvaite). The bands of the etching figures are not of uniform width nor do they extend continuously for any great distance. They are of the type described by German writers as "*wulstige*" (swollen). The longest one is 11 mm. (0.45 inch) in length and its contour is very irregular. Only the two alloys, kamacite and tænite, seem to be present. The former is iron gray in color and occasionally has a well-marked granular structure. The latter, filling the areas between the kamacite bands, is now more or less ribbonlike and now occurs in curvilinear areas. Much of it appears connected through the section, giving the impression of a network in which the kamacite is embedded. It shades to a bronze color as contrasted with the iron gray of the kamacite and is left standing in relief by the etching. Under the lens its surface appears very rough, the etching of the acid acting upon it more irregularly than upon the kamacite. The only other mineral appearing in abundance in the meteorite is schreibersite, which occurs in long narrow bands or in irregular starlike forms. These areas are bounded by kamacite (swathing kamacite). Decomposition has taken place usually along the schreibersite bands, and these decomposed areas appear as dark marks on the etched surface.

Troilite seems to be almost entirely absent from the meteorite. Only two minute nodules are to be seen on the surfaces which have been etched and the percentage of sulphur obtained by analysis corresponds to a content of only 0.07 per cent. The presence of cohenite is indicated by the carbon found by analysis, but it was not observed on the etched surfaces.

An analysis of the meteorite was made by Mr. H. W. Nichols, the methods employed being briefly as follows: Material for the analysis was secured by a boring made with a 0.25-inch drill. The amount of substance used was 2.4353 grams. In order to prevent loss of sulphur and phosphorus the borings were placed in a flask and first treated with fuming nitric acid, to which they remained passive, and then hydrochloric acid was gradually added cold until

solution was complete. Sulphur was weighed as barium sulphate. Phosphorus was determined by Eggertz's method as phosphomolybdate, the quantity being too small to allow of a magnesium pyrophosphate determination. Iron was separated by one ammonia and three basic acetate and one final ammonia precipitation. Manganese was separated by the sodium acetate method. Copper, cobalt, and nickel were precipitated as sulphides in acetic acid solution, cobalt and nickel separated by potassium nitrite, and all weighed from electrolytic deposition. Carbon was determined in an independent sample by oxidation in chromic acid after the method described by Blair.

The analysis gave the following results:

Fe	90.56
Ni	7.71
Co	1.07
Cu	0.14
Mn	Trace.
P	0.24
C	0.01
S	0.025
Si	0.006
Insoluble	0.09
	99.85

Omitting silicon and insoluble matter the analysis indicates that the meteorite has the following mineralogical composition:

Nickel iron (Fe, Ni, Co, Cu, Mn)	97.98
Schreibersite	1.55
Cohenite	0.15
Troilite	0.07
	99.75

As the locality where the meteorite was found may be said in a certain sense to be in the vicinity of Toluca, it becomes an important question from the standpoint of the collector to determine whether the specimen is to be regarded a portion of the Toluca fall. Los Reyes is about 40 miles (62 km.) in a direct line east of Toluca. It is the little station at the southern end of Lake Texcoco where the Morelos division of the Interoceanic Railway joins the main line, about 12 miles southeast of the City of Mexico. On the same line of railroad 25 miles from the City of Mexico is the town of Ameca-Ameca where the find of another iron meteorite has been reported by Castillo. Castillo classes this iron with the Toluca meteorites, and describes the "zone" of Toluca meteorites as extending from Ameca-Ameca on the east to Xiquipilco in the valley of Toluca [on the west]. If Castillo is right in this conclusion the Los Reyes meteorite comes within this zone, as Los Reyes is some 15 miles (23 km.) nearer Toluca than Ameca-Ameca. Castillo unfortunately gives no description of the Ameca-Ameca meteorite by which its resemblance or otherwise to the known specimens from Toluca can be determined. He simply describes it as a "small nodule of meteoric iron found in the village [of that name] and now preserved in the National Museum of Mexico." If it is correct thus to group the Ameca-Ameca meteorite (and hence Los Reyes) with Toluca, a distribution of 50 or 60 miles at least must be conceded to this fall, Ixtlahuaca and Xiquipilco, the two localities in the Valley of Toluca where many of the Toluca meteorites are found, being 10 miles farther from Ameca-Ameca than Toluca itself. It will be remembered that Fletcher, after a careful study of Mexican meteorites with especial regard to the supposed occurrence of widespread meteoritic showers, reached a negative conclusion as regards the wide extent of such showers, this opinion being similar to one in regard to such showers in general which he had expressed in an earlier paper. According to Fletcher the distribution of the Toluca meteorites as they have been reported from localities distant from Toluca was probably due to human agency. With reference to the Ameca-Ameca meteorite he states that "Ameca-Ameca is a town where there are now iron foundries, and where plows, castings, smoothing irons, mill wheels, and other articles are manufactured," to show that Toluca iron might have been carried there for manufacturing purposes. With regard to this report of the state of manufacturing enterprises in Ameca-Ameca, I fear that the distinguished authority of the British Museum has been misinformed, for I have spent weary days in the town without having learned of the existence of such industry.

The fact brought out by Fletcher to the effect that no known meteorite shower has a greater distribution than 16 miles is a more important one in the study of this case, and the evidence at hand in this instance is hardly sufficient to enable us to assert that the Toluca shower had a wider extent.

The meteorite may of course have reached Los Reyes by the agency of man, but on the whole the indications are that it fell where it was found. The statements of the finders were plain and simple, the meteorite bears no marks showing any attempt to use it for economic purposes, and the price at which it was purchased was lower than any one who had brought it from Toluca would probably have sold it for. If the iron fell where it was found it is important to determine whether it was an independent fall or whether its resemblance to known Toluca irons is sufficient to make it probable that it fell at the time of the Toluca shower. Here again no positive evidence is at hand, but the chances are, in my opinion, in favor of the latter conclusion. The meteorite certainly does not differ sufficiently from known Toluca irons so that its independent origin can be asserted, and on the whole it resembles them considerably. Published analyses of Toluca irons give percentages varying somewhat widely, within which limits the Los Reyes values

may certainly be included. For purposes of comparison of analyses, several that have been made of Toluca irons by different authorities are given below:

1. Taylor, Amer. Jour., Sci., 3d ser., XXII. 374. 1856.
2 and 3. Pugh, Annal. der Chem. und Pharm. XCVII. 385. 1856.
4. Nason, Jour. Prakt. Chemie. LXXI. 123. 1857.

	1	2	3	4	Los Reyes.
Fe	90.72	90.74	87.89	90.133	90.56
Ni	8.49	7.78	9.06	7.241	7.71
Co	0.44	0.72	1.07		1.07
Cu	....	0.03	....	....	0.14
Mn	....	....	0.20	....	trace
S	....	0.03	....	trace	0.025
C	....	....	....	....	0.01
P	0.18	0.24	0.62	0.376	0.24
X	0.63	....	0.22	2.225	....
Insoluble residue	....	0.34	....	....	0.096
	100.46	99.88	99.06	99.975	99.851

The resemblance in chemical composition to the average of Toluca irons is thus seen to be close. Further, the etching figures come within the limits found in Toluca irons, since these vary considerably in detail as is well known. The meteorite will be designated, therefore, as Toluca (Los Reyes).

The features of the above account which seem to warrant regarding the meteorite an independent fall are the distance (40 miles) of its place of find from Toluca and the abundance of schreibersite and lack of troilite which the meteorite shows. In the Toluca meteorites schreibersite is usually lacking or occurs only in compound nodules, and troilite is abundant.

The meteorite is preserved entire in the collection of the Field Museum, Chicago.

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LOSTTOWN.

Losttown Creek, Cherokee County, Georgia.
Latitude 34° 10′ N., longitude 84° 30′ W.
Found, 1868.
Iron. Medium octahedrite (Om), of Brezina; Lockportite (type 16), of Meunier.
Weight, 3 kgs. (6 lbs. 10 ozs.)

This mass was first described by Shepard,[1] as follows:

This iron was plowed up in April, 1868, on the farm of Mr. Michael Sullivan, 2.5 miles southwest of Losttown, Cherokee County, Georgia. It weighs 6 pounds, 10 ounces, and has a very striking resemblance in form to a human foot. Its color is almost perfectly black, and is wholly free from stains of iron rust. It exhibits no tendency to exfoliation, nor is it uniformly covered by a fused coating. Widmannstätten figures are visible directly in one portion of the surface. The indentations are broad and shallow, though on the whole well pronounced. A thin slice weighing 27 grams was sawed from the heel end of the mass. The hardness proved uniform, no pyrites having been encountered in the section. The specific gravity of the fragment is 7.52. On being etched with dilute nitric acid, very beautiful Widmannstätten figures were presented, not quite identical with any with which I am acquainted, but most nearly resembling those of the Seneca Lake iron, the difference between the two consisting mainly in a less breadth to the bars by about one-third in the former of these irons. I have thus far found time only to examine the filings (or rather sawings) of this iron for sulphur and nickel. The first is wholly wanting, while the latter is abundantly present.

A year later Shepard [2] gave an analysis of the meteorite as follows:

Fe	Ni	Cr, Co, Sn, Mg	Insoluble residue	
95.759	3.660	traces	0.58	=99.999

Brezina [3] described the structure as follows:

Losttown presents a somewhat irregular structure; plates 0.4 to 0.6 mm. broad; lamellæ partly grouped, partly isolated, always puffy; kamacite flecked, sometimes granular, sometimes not; tænite well developed, fields now large and predominating over the kamacite, now almost lacking, generally dark, flecked, and glistening, for the most part entirely without combs; in the infrequent case where combs are present, they fill the fields entirely. Schreibersite is abundant and irregularly distributed.

Both Brezina and Wülfing included the Canton meteorite under this fall, but erroneously, since the latter is of different structure.

The locality, Losttown, given by Shepard[1] is not shown on maps as a settlement. There is, however, a creek by this name in Cherokee County to which locality the meteorite can probably be referred with propriety.

The principal mass of the meteorite (6 pounds, 10 ounces) is in the Amherst College collection.

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2. 1869: SHEPARD. Notices of new meteoric irons in the United States. 3. Composition of meteoric iron from Losttown, Cherokee County, Georgia. Amer. Journ. Sci., 2d ser., vol. 47, p. 234. (Analysis.)
3. 1895: BREZINA. Wiener Sammlung, p. 279.

Louisiana. See Red River.

LUCKY HILL.

St. Elizabeth, Jamaica, West Indies.
Latitude 18° 10′ N., longitude 77° 20′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found, 1885.
Weight (assignable), 3,406 grams (7 lbs.).

Regarding the history and characters of this meteorite little or nothing seems to have been published. It is mentioned in several catalogues with the above data, but no more. The first mention seems to have been by von Hauer[1] in 1886.

Brezina[2] makes the following mention:

Lucky Hill (medium octahedrite) is a deeply divided iron which in pieces is entirely broken up into lamellæ.

Wülfing[3] includes in the literature of this fall an account of a meteor seen by Barham in Jamaica about 1700, the account being published in 1720. There seems to be no reason for connecting the two, however.

The meteorite is chiefly preserved (3,280 grams) in the Museum of Practical Geology, London.

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2. 1895: BREZINA. Wiener Sammlung, p. 282.
3. 1897: WÜLFING. Die Meteoriten in Sammlungen, p. 215.

LUIS LOPEZ.

Socorro County, New Mexico.
Latitude 34° N., longitude 106° 58′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found, 1896.
Weight, 6,903 grams (15 lbs.).

This meteorite has been described wholly by Preston[1] as follows:

The Luis Lopez siderite is somewhat rectangular in shape and measures 80 by 130 by 195 mm. in its greatest diameters; it is the property of Prof. Henry A. Ward, of Chicago.

When received by Professor Ward it was entire, lacking possibly 40 or 50 grams that had been sawed off one of the prominent protuberances. The actual weight when received was 6,903 grams. The general shape of the mass was quite symmetrical and covered on all sides with large and prominent pittings.

The outer surface was entirely covered, save the small cutting, with a rather lustrous reddish-brown crust. On cutting the mass numerous troilite nodules ranging in size from 8 to 28 mm. in diameter were found, some sections containing as many as four nodules of large size. There were numerous straight fissures 1 mm. or less in thickness, and from 40 to 70 mm. in length, which are filled with troilite.

On etching the surface of these sections the Widmanstätten figures are brought out, sharp and distinct; they are typically octahedral, and composed of broad laminæ, the kamacite bands being from 1 to 3 mm. in diameter, and up to 41 mm. in length, in some cases without a break.

There are also numerous small streaks or seams of schreibersite, the longest as far as observed being 8 mm. and a trifle less than 1 mm. in width.

The troilite nodules are likewise surrounded by a very narrow band of schreibersite, which presents a strong contrast between the silvery white kamacite bands and the bronze-colored troilite nodules. In some few instances a black graphitic substance from 1 to 3 mm. in width is seen surrounding the troilite nodules between the narrow band of schreibersite and the kamacite. The minute hairlike lines commonly called laphamite markings are abundant in the rhomboidal patches known as plessite. These lines are caused by minute alternating layers of kamacite and tænite, plessite, as proved by J. M. Davison, being formed in this way, and not a different nickel-iron alloy as formerly supposed.

This meteorite was found in the early part of 1896 by a Mexican named Gonzales, who was very reticent for a long time about giving its exact locality, supposing he had found indications of a valuable mine. But later Mr. T. C. Brown, of Socorro, New Mexico, succeeded in obtaining the mass, and was informed by the Mexican that he had made further search for more pieces but found none. He had picked this piece up about 5 miles southwest of Socorro near the hamlet of Luis Lopez.

In the autumn of 1896 the mass as found passed into the possession of Mr. A. B. Fitch, of Magdalena, New Mexico, who retained it in his possession until June, 1899, when it was purchased by Professor Ward.

From its near proximity to the above hamlet we will designate this siderite as the Luis Lopez meteorite, Socorro County, New Mexico.

An analysis by Mariner and Hoskins, of Chicago, gave:

Fe	Ni	Co	Si	P	S	C	
91.312	8.17	0.160	trace	0.333	0.013	0.012	=100.00

Specific gravity, 7.7.

The meteorite is distributed, Ward possessing the largest amount, 3,124 grams.

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LUMPKIN.

Stewart County, Georgia.
Latitude 32° 3′ N., longitude 84° 45′ W.
Stone. Crystalline spherical chondrite (Cck) of Brezina.
Fell 11.45 a. m. October 6, 1869.
Weight, 357 grams (12.25 ozs.).

Mention of this fall was made in the American Journal of Science for September, 1870,[1] and in the following November a full account was published by Willet[2] as follows:

In October, 1869, I learned that a meteoric explosion had taken place in Stewart County, Georgia. I immediately requested Hon. John T. Clarke, a resident of the county adjoining Stewart, to inquire whether any stone or stones had fallen, and to endeavor to procure them for Mercer University. Judge Clarke, after considerable labor, was entirely successful in his search; and through him Mr. Barlow, in whose yard the meteorite descended, generously presented it to our museum. To Judge Clarke and to Mr. Latimer I am indebted for the following history of the phenomena attending the descent of the meteorite.

Mr. J. B. Latimer, of Bladens Creek, Stewart County, has kindly furnished the following particulars of the flight of the body through the air, and of the several explosions which occurred nearly vertically above him:

"The morning of October 6, 1869, was quite clear, scarcely any cloud being visible, and was quite calm; about 10 a. m. the atmosphere grew somewhat hazy, no clouds; at about 15 or 20 minutes before 12 m. a roaring, rushing sound was heard in a northwesterly direction, about 80° above the horizon. In a moment or two it was almost directly overhead, at which point a loud explosion occurred, followed in rapid succession by six other reports, but less in volume than the first, making seven in all. The explosions appeared as loud as a 12-pound cannon at a distance of 10 or 12 miles. These explosions did not occur all at the same point in the heavens, but seemd to emanate from some body moving rapidly to the southeast. After the explosions a peculiar whirling sound was heard, apparently produced by some large irregular body moving very rapidly. This also went in a southeasterly direction. This sound was heard for several seconds; many have compared it, and aptly too, to an imperfect steam whistle. I have no precise idea of the time consumed in all this demonstration; some persons say several minutes, but I think 10 or 15 seconds would about cover the time.

"As the larger body was going out of hearing, some moments after the explosions, a smaller one passed to the southwest, with just such a noise as is always produced by a flying fragment of a shell after its explosion or of any angular body cast violently through the air. This piece descended to the earth, distinctly traced in its passage by many persons, and struck in the yard of Capt. E. Barlow, which point of contact is, on an air line, about 2.5 miles from a perpendicular beneath where the explosions occurred. This is the only one known to have fallen in this section.

"The explosions, together with the rushing sound afterwards, were heard over a region about 30 miles northeast and southwest and 50 or 60 miles northwest and southeast. No shock was felt, at least no tremor of the earth.

"Two men say that they were looking in the exact direction of the explosions at the time they occurred, and saw a quantity of vapor, much like the volume of steam escaping from the pipe of an engine, at each successive stroke; which vapor or mist was violently agitated, and increased in bulk with each successive report, but disappeared soon after the cessation of the reports. This corroborates the testimony of some of my own laborers, who say that immediately after the explosions something like a thin cloud cast its shadow over the field they were in."

Hon. John T. Clarke, of Cuthbert, Georgia, who has interested himself in collecting the history of the meteorite, and through whose influence it has come into the possession of Mercer University, writes me the following particulars of its fall:

"It fell about 11.30 a. m. on October 6, 1869, in Stewart County, Georgia, on the premises of Elbridge Barlow, about 12 miles southwest of Lumpkin. Captain Barlow picked it up a few moments after it fell. His account of it is this: While standing in the open yard, the sky being bright and clear, he heard first a succession of about three explosions, followed by a deep roaring for several seconds, and then by a rushing or whizzing sound of something rushing with great speed through the air near by. The sound ceased suddenly. The noise continued from first to last about half a minute. Two negroes were washing near the well in the same yard, about 60 yards from where Mr. Barlow stood. They heard the noise and supposed it to be the falling in of the plank well curbing, banging from side to side in its descent, and so spoke of it to one another before the meteorite fell. While they were speaking thus about the noise, the meteorite fell and struck the ground about 20 steps from them, in full sight, knocking up the dirt. They called Captain Barlow and showed him the spot. It was upon very hard trodden ground in the clean open yard. The earth was freshly loosened up very fine in a circle of about 18 inches in diameter, and upon scraping the loose dirt away with the hands the stone was found about 10 inches below the surface. From the direction in which the ground was crushed in it must have come from the northwest, and at an angle of about 30° with the horizon. The stone when picked up was covered all over with the black shell which it has now, except a triangular spot on one corner about 1 inch each way, where the corner appeared freshly knocked off; and about four other spots near a quarter of an inch in diameter where the shell was slightly knocked off. The other bruises which are found upon it have been made since its fall by persons who have handled it. The stone still has a strong odor. Captain Barlow says it smelled stronger when he first picked it up. He does not remember that it had any noticeable heat. It was not cold, as a stone found so deep in the ground should be.

"The stone weighs now 12.25 ounces; about 0.5 ounce has been pecked off from it. Its color within is strikingly like very light granite; and, with the exceptions above noted, it is entirely covered with a smooth almost black shell, a trifle thicker than common letter paper, so that externally it looks very much like a lump of iron ore. It is an irregular seven-sided figure, its longest side being about 2.75 inches long. If put into a spherical form it would make a ball about 1.75 inches in diameter. So far as I have been able to ascertain no other parts have been found.

"The noise attending this phenomenon is variously described by different persons, and from different places. Two intelligent ladies residing about 4 miles south of Lumpkin, nearly east of where the stone fell and about 10 or 12 miles off, describe it thus: While sitting in the house they heard, as it were, the sound of a great fire suddenly bursting forth from some confinement into the open air. They rushed out of doors and heard the roaring sound continuing for several seconds. They located the source of the noise in the direction of Barlow's.

"In Cuthbert, about 18 miles nearly southeast from Barlow's, a gentleman engaged in a workshop heard a lumbering noise, which he took to be several heavy pieces of machinery in an adjoining room falling down one after another. On going in he found no one, and thought that he had mistaken the cause of the noise. Many persons here heard sounds like repeated thunder followed by roaring. Some say that they first heard several rapid, crackling explosions, like that of volleys of small arms, followed immediately by the louder burst of artillery. Most persons here thought the noise came from the southeast, passed over the place in a northwesterly direction, and died away in the distant northwest.

"The foregoing statements have been selected from many in circulation showing how differently the senses were affected at different points. The facts are purposely presented in their nakedness."

The above accounts agree as to the main facts. They were furnished by Mr. Latimer and Judge Clarke, without being compared by them. It is possible that a comparison of notes by them might have thrown some light on the point of greatest discrepancy, viz, the direction of flight. It is probable that the meteorite came from some point in the north quarter; the statement of Mr. Latimer, over whom it exploded, and that of Mr. Barlow as to the direction in which the earth was penetrated, concur in this regard. Persons in Cuthbert, who represent it as coming from the south, may have been mislead by an echo, mistaking this for the original sound.

Prof. J. Lawrence Smith, who is giving special attention to the subject of meteorites, has requested the privilege of analyzing the stone above described.

Smith's[8] article is as follows;

In October, 1869, I learned through the public press that certain meteoric phenomena had occurred in Stewart County, Georgia, and that one or more stones had fallen. Inquiries were immediately instituted by me and through Professor Willet I obtained for examination the only stone found, one that was seen to strike the ground, and from him received an account of the phenomena observed at the time by Messrs. Latimer, Clarke, and others. The stone as it reached me was nearly intact and weighed 12.25 ounces; it must originally have weighed 12.5 ounces. It

is of an irregular conical shape, having a flattened base, and is covered with a dull heavy black coating. The specific gravity is 3.65. The fractured surface has a grayish aspect, and when examined closely, especially by the aid of a glass, exhibits numerous greenish globules with a whitish granular material between; through the mass are dark particles consisting principally of nickeliferous iron, with some pyrites and a few specks of chrome iron. The nodules are sometimes 3 or more millimeters in diameter, and of an obscure fibrous crystalline structure, the crystals radiating usually from one side of the nodule; they have a dirty bottle-green color, a greasy aspect when broken, and more or less opaque.

Some of these little nodules were separated in a tolerable state of purity, amounting to 121 milligrams; on analysis they afforded:

		Oxygen ratio.	
Silica	48.62	29.90	2
Alumina	8.05	3.79	
Iron protoxide	11.21	2.51	1
Magnesia	30.18	11.80	
	98.06		

The hardness of the mineral is about 6, and it is quite tough. The formula would be RO, SiO_2, with a part of the silica replaced by alumina, a not infrequent case in minerals such as hornblende, hypersthene, etc. As it is impossible to derive any light from its crystalline structure the above analysis warrants me in concluding that it is either bronzite or hornblende, but I am more inclined to the former supposition, as it appears to take the place of enstatite in many meteorites. Nickeliferous iron constitutes about 7 per cent of the mass, and a portion separated in as pure state as possible afforded on analysis:

Fe	Ni	Co	
86.92	12.01	0.75	=99.68

These are the proportions after allowing iron for a small amount of sulphur, present in a minute quantity in the nickeliferous iron, which could not be separated mechanically. I did not test for copper or phosphorus; the quantity of iron separated from the stone did not warrant my making special analyses for substances, the quantity of which present could only be exceedingly minute.

The stony matter freed from the iron was treated with nitro-hydrochloric acid and water, and heated for some time over a water bath, renewing the water and acid once or twice; the solution was filtered, and the residue washed; the residue was then treated with a warm solution of caustic potash, filtered and again washed. The filtrate was neutralized by hydrochloric acid, and added to the first filtrate, and the whole evaporated to dryness over a water bath, warmed gently over the lamp, and treated with water and a little hydrochloric acid, thrown on a filter, the silica collected and estimated; the last filtrate was treated with a solution of hydrochlorate of baryta to ascertain the quantity of sulphuric acid present (due to the pyrites in the original mass); it was found to indicate 6.10 per cent of magnetic iron pyrites. The solution freed from the excess of baryta was now analyzed in the ordinary way.

The insoluble portion of the meteorite was fused with carbonate of soda and a small fragment of caustic potash, and its ingredients ascertained.

A separate portion of the stony part of the meteorite was examined for alkalies.

The various analyses referred to above gave, omitting the nickeliferous iron:

The part soluble in acid	58.05
The part insoluble in acid	41.95

	Soluble part.	Insoluble part.
Silica	41.08	56.03
Alumina	0.32	5.89
Protoxide of iron	18.45	15.21
Magnesia	41.06	21.00
Lime		0.10
Soda, with a little K and Li		2.97
	100.83	101.20

The soluble part consists principally of olivine. The insoluble is doubtless the bronzite already referred to, with a little albite or oligoclase.

Chrome iron was detected by fusing some of the stony part of the meteorite with carbonate of soda and a little niter, and separating in the usual way. The quantity was quite minute.

The composition of the stone as made out would be:

Nickeliferous iron	7.00
Magnetic pyrites	6.10
Bronzite or hornblende, Olivine, Albite or oligoclase, Chrome iron	86.90
	100.00

Brezina [4] on account of their peculiar combination of brecciated and crystalline characteristics would classify Richmond and Lumpkin together as a separate group under the name of half-crystalline spherical chondrites (Cckb).

The small amount of the meteorite known is distributed, Harvard possessing 61 grams.

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4. 1885: Brezina. Wiener Sammlung, pp. 191 and 233.

McKINNEY.

Collin County, Texas.
Latitude 33° 13′ N., longitude 96° 35′ W.
Stone. Black chondrite (Cs) of Brezina.
Described, 1895.
Weight, two masses, the larger about 100 kgs. (220 lbs.)-

The only description published of this meteorite seems to have been by Brezina [1] as follows:

McKinney is distinguished by the manifold variety of its chondri and its black luster, but, however, can not be identified positively with the black chondrites, inasmuch as the black color is not certainly referable to a carbon content. The principal part of the larger of the two stones discovered (weighing originally 100 kg.) has a weight of only 40 kg., is semilenticular in form and shows the convex surface rough, pitted, and somewhat altered to limonite, and mostly without recognizable fusion crust, except in traces in a very few places. Broken surfaces of the stone often follow cleavage cracks, along which the formation of limonite has taken place, in some instances to the extent of forming bright iron ocher flakes or layers. Near the surface, chips the size of a man's hand and from 1 to 15 mm. in thickness may be pried off. The brittle, splintery character of the mass also frequently affords very thin, even chips. In many places troilite accumulations in the form of quite irregular veins 0.5 to 1 cm. thick, traverse the stone, in which the very abundant troilite takes the place of the very sparing nickel-iron. The termination of such troilite veins upon the natural surface of the mass consists of pits 0.5 cm. deep from which the troilite has been melted out. Troilite nodules as large as walnuts are also found, sometimes with, sometimes without accompanying troilite veins. Nickel iron occurs only in quite isolated and rather abundant accumulations; in one instance, in a cavity 1 mm. in size, are found variegated swollen hexahedrons of the same. The manifold variety of the chondri, some of which attain a diameter of 1.5 cm., is very great. The most abundant are leek-green to olive-green, of a dull to greasy luster in fracture, foliated or (less frequently) monosomatic. These appear to consist of olivine; they blend occasionally with the groundmass, are generally round, seldom flattened, have frequently a bright, sometimes jagged core, and a dark to greenish-black shell, which is occasionally surrounded with a band of troilite, or more seldom with grains of iron. In the latter case the iron appears also as interstitial matter in the interior of the chondrus. Besides these most numerous chondri there appear also those which are bright yellow, dull, or of a slightly waxen luster; also greenish to wood-brown, radio-fibrous, silken chondri in fragmentary form, and those which are bright pistachio-green, dull or slightly glistening to dark pistachio- or blackish-green, brightly glistening; again some are black or blackish-green, eccentrically or parallel rayed, beautifully glistening; and as rare exceptions those which are entirely black and lusterless. In one case there is found a dull olive-green chondrus, 3 mm. in size and penetrated by a glistening lamella (or fault?). Very rarely entire chondri of 1 to 2 mm. are to be found.

The meteorite is distributed, Ward's [2] catalogue stating that his collection contains the largest amount, 51,230 grams.

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2. 1904: Ward. Catalogue of the Ward-Coonley Collection, p. XII.

Macon County. See Auburn.

Madison County. See Jewell Hill.

MADOC.

Madoc township, Hastings County, Ontario.
Latitude 45° 31′ N., longitude 73° 35′ W.
Iron. Fine octahedrite (Of) of Brezina; Madocite (type 10) of Meunier.
Found, 1854; described, 1855.
Weight, 167.5 kgs. (370 lbs.).

The first mention of this meteorite was by Hunt,[1] as follows:

A large mass of native iron was found last autumn upon the surface of the earth in the township of Madoc, Ontario; it has since been procured by Mr. Logan, the director of the Geological Survey, in the collection of which it has been placed. The mass is rudely rectangular and flattened, but very irregular in shape; its surface is deeply marked by rounded depressions which are lined with a film of oxide. It closely resembles in appearance the Lockport, New York, iron, with which it seems to agree in composition; a single analysis gave 6.35 per cent nickel, in which no cobalt was detected. The iron is very soft and malleable, and from a trial with a small fragment exhibits a coarsely crystalline structure; the weight of the mass is 370 pounds. We purpose to have it cut, and I shall then be able to make a more complete examination of the iron.

The history and characters of the meteorite have been further given by Cohen,[5] as follows:

Reichenbach [2] described Madoc as containing kamacite, tænite, and plessite; the latter was quite dark and full of combs. He also mentioned grains of bronze-colored iron sulphide with inclusions of numerous needles and with an envelope of tænite and a coating of rust with specks of iron glass.

Brezina [3] gave the following charactersitics: "Bands long, closely compacted together, hatched, 0.3 mm. in width, granulated; bands and combs few."

Meunier [4] made of Madoc a new type, viz, madocite. According to him nodular plessite strongly predominates, tænite is present in fine, often slightly regular scales, and kamacite is extremely scarce; schreibersite occurs in rods somewhat resembling those of Magura.

The section examined by me shows long, sometimes straight, sometimes bent, occasionally much compacted, granular bands, inconspicuous tænite seams, and numerous fields which are inconspicuous in comparison with the bands; the former do not show up very distinctly, since in comparison with the bands in respect of color and luster there is no marked distinction. The kamacite is somewhat speckled in places and shows many distinct file marks accompanied with comparatively large etching pits. It has also a satiny oriented luster of considerable brightness. The plessite is composed principally of sometimes approximately isometric and sometimes elongated grains measuring 0.05 to 0.20 mm. in thickness, which are sharply separated from one another by dark deep grooves; in some fields the grains are elongated to granular rods measuring 0.25 to 0.4 mm. in thickness and of slightly regular form. It is characteristic of this plessite that it is appearently free from tænite or scales resembling tænite. Fields with dark compact plessite and almost microscopic in size occur only occasionally and then only in entire isolation, so that the absence of such fields to the unaided eye may be regarded as characteristic. Minor constituents seem to be very scarce, but troilite, schreibersite, and iron glass were observed.

Madoc has a very prominent alteration zone of varying breadth. The boundaries of the lamellæ in it can be readily distinguished, but the structure of the kamacite is sometimes speckled and sometimes decidedly granular. The color of the etching surface is darker and the luster duller in this zone.

The meteorite is chiefly preserved in the Museum of the Canadian Geological Survey, Ottawa, Canada. Small sections are distributed.

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3. 1885: Brezina. Wiener Sammlung, p. 210.
4. 1893: Meunier. Revision des fers météoriques, pp. 39–40.
5. 1905: Cohen. Meteorintenkunde, Heft 3, pp. 354–356.

Marengo. See Homestead.

MARIAVILLE.

Rock County, Nebraska.
Latitude 42° 45′ N., longicude 99° 25′ W.
Iron.
Fell? October 16, 1898, between 12 and 1 a. m.
Weight, 340 grams (12 ounces).

Our only knowledge of this meteorite is a brief note by Barbour,[1] who stated that the finder said it had fallen in Mariaville, Rock County, Nebraska, between 12 and 1 o'clock on the

night of October 16, 1898. The finder also stated that it was luminous and made a loud noise in its descent. A photograph showing the shape of the meteorite to be elongated or somewhat gourd-shaped was published by Barbour.[1] The surface also shows pittings and protuberances.

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MARION.[a]

Linn County, Iowa.
Here also Hartford and Linn County.
Latitude 42° 2′ N., longitude 91° 35′ W.
Stone. Veined white chondrite (Cwa); Luceite (type 37, subtype 2), of Meunier.
Fell 2.45 a. m., February 25, 1847.
Weight, 21 kgs. (46 lbs.). Three stones, two of about 20 lbs. and one of about 3 lbs.

The first account of this meteorite was given by Shepard,[1] as follows:

The present notice is only for the purpose of announcing a few particulars respecting this last fall of stones in the United States. Fuller details of the occurrence, together with a description of the meteorite, will be reserved for a future occasion. The facts here presented are derived from the Rev. Reuben Gaylord, of Hartford, Des Moines County, Iowa, who visited the locality at my request, and has collected for me whatever specimens could be procured, by far the greater part having been broken to small fragments and lost, as it is feared, to the purposes of science. The fragments forwarded to me by mail, and which are referred to in the following letter, leave no doubt of the genuineness of the production described. They consist of little globules of nickeliferous iron dispersed through the grayish feldspathic mineral, so common in meteoric stones. The fall took place in Linn County, and is well described in the following letter of Mr. Gaylord:

"I proceed now to give you the results of my investigation of the facts in relation to the meteor which fell in our State, in respect to which you wrote me some time since. Having learned particulars so far that I had full reason to credit the reports in the case, I repaired to the spot last week and found the facts to be as follows: On February 25, 1847, at about 10 minutes before 3 o'clock in the afternoon, the attention of the people in that region was arrested by a rumbling noise as of distant thunder; then three reports were heard one after another in quick succession, like the blasting of rocks or the firing of a heavy cannon half a mile distant. These were succeeded by several fainter reports, like the firing of small arms in platoons. Then there was a whizzing sound heard in different directions, as of bullets passing through the air. Two men were standing together where they were at work; they followed with their eye the direction of one of these sounds, and they saw about 70 rods from them the snow fly. They went to the spot. A stone had fallen upon the snow, had bounded twice, the first time, as was supposed, about 8 feet and the second time about 2 feet. The stone weighed 2 pounds 10 ounces. The same persons heard another stone strike as it fell, supposed to be small, but they could not find it. Some time in the spring, another stone was found about 1.25 miles west from the place where this fell. It was in two pieces, lying together, weighing 46 pounds. Another fragment, a portion of the same rock, was found about half a mile from the former, which, from the description I had of it, I judged would weigh about 50 pounds. These were coated with a thin black covering. The principal ingredient in their composition seems to be sandstone. They are full of minute brilliant particles and occasionally a small lump of some metal is to be found. Inclosed in this sheet I send you three or four small ones. Some were taken out as large nearly as a grain of corn. A man from whom I obtained a fragment insisted that they were silver. He had ground up a considerable portion of the rock to obtain this silver, and he thought he had saved enough to make 50 cents (half a dollar). The above stones were all that have been found, as far as I could learn. The atmosphere at the time of this phenomenon was mostly clear, somewhat hazy, so warm as to cause the snow on the ground to be somewhat soft. The noise was heard distinctly to a distance of 15 or 20 miles in every direction. At a distance of 10 miles in each direction the sound was like the rolling of a heavy wagon passing swiftly over frozen ground. Smoke was seen in the direction from which the sound seemed to proceed. The smoke appeared in two places, apparently about 6 or 8 feet apart, above the elevation of light clouds, and having a circular motion. The motion of the meteoric body was supposed from the reports which were heard to be toward the southeast, or rather south of east."

In a letter to J. J. Abert, Columbia Topographical Bureau, Washington, Joshua Barney,[2] United States agent at Dubuque, Iowa, stated that an aerolite weighing 2 pounds 10 ounces—

fell at 3 o'clock in the afternoon of February 25, 1847, within 75 yards of the house of Daniel Rogers, 9 miles due south of Marion, Linn County, Iowa. The ground was covered with snow at the time it fell. Mr. Rogers heard a loud explosion in the air and immediately ran to his door. He heard the stone and several others whiz through the air and strike the ground, and saw the snow and dirt fly where this stone struck. The weight of the stone before it was broken was 42 pounds.

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[a] This meteorite was long known as Hartford, Linn County, but as shown by Farrington [1] Hartford is 100 miles from the place of fall.

It is said that three more of the stones have been found, all of which are precisely similar in appearance and nearly of the same weight as this one before it was broken.

The explosion was heard distinctly by one of the surveyors who was engaged on the survey of the public lands 40 miles distant from Mr. Rogers's house.

A more complete description of the meteorite was given later by Shepard [3] as follows:

The small stone seen to fall was picked up on the land of Mr. Daniel C. Rogers, situated on sec. 21, T. 82 N., R. 6 W. The larger portion of the fallen meteor was found in section 20, from 1 to 1.5 miles west. This consisted of two masses and not, as at first supposed, of two fragments of a single stone. The larger of the two (whose weight was estimated at above 40 pounds) was cracked through the center by its fall upon the frozen ground. One of these halves (weighing 21 pounds 7 ounces) is in my possession. The smaller perfect stone is represented by the finder as pyramidal in shape and measuring 10 inches in length, by 8 at its base, and 4 at the smaller extremity. It was completely coated by a black crust, like the other two stones. This stone, as well as one-half the larger mass, has been broken up, and for the most part entirely lost. The few fragments of it in existence show that it differs scarcely at all from the other two.

The smaller of these two may be best described by comparing it to a short rectangular prism (the longer side measuring 4 inches, the shorter 2.5 inches) surmounted at one extremity by a four-sided pyramid of unequal and much-curved faces, and terminated at the opposite end by an oblique, waving plane, upon which the stone is conveniently set up When in this position the apex of the pyramid is 3.5 inches from the base. The angles and edges of the mass, as is usual in such bodies, are rounded and blunt. It has but few depressions in its surface. The crust is perfect in its continuity and is smooth and black, though not shining. The stone weighs 2 pounds 8½ ounces.

The large mass (of 21 pounds 7 ounces) is an irregularly shaped, four-sided pyramid, the summit of which is an edge of 4 or 5 inches in length. The base of the pyramid is formed by the fractured surface, which is nearly plane, and strikingly resembles the fracture of fine-grained granite.

The natural outside of the stone presents the customary depressions, though less distinct than is usual. The crust is similar to that of the small stone already described, only thicker than common (being of the thickness of bonnet board), its adhesion to the unaltered stone strong, while its line of junction with the same is perfectly defined throughout. When narrowly observed it is discovered that the surface of this crust is divided off by cracks into polygonal areas of from 0.25 to 0.5 inch in diameter, in consequence no doubt of sudden cooling.

The color of the stone within is a uniform pearl gray. A closer inspection reveals specks of iron rust, though less abundant than common, and numerous highly brilliant globules of nickeliferous iron. It requires a still nearer search to detect the magnetic pyrites, which is far less abundant than the metallic grains. Blackish grains and glazed joints are nearly obsolete in the Iowa stones. The same may be said of the little ovoid masses, which are also so frequent in most other stones.

Its most remarkable feature, however, consists in the homogeneousness of its earthy composition. It appears to contain but a single mineral species of this description and this is one which, though perhaps the most common in other meteoric stones, has until now escaped a separate recognition. I have therefore ventured to bestow upon it a distinct name, that of howardite, in honor of an early scientific laborer in this branch of meteorology who ranks next in importance to Chladni himself.

The proportions of the ingredients in this stone approach the following:

Howardite	83.00
Nickel iron	10.44
Magnetic pyrites	5.00
Olivinoid and anorthite	trace
	98.44

Omitting the pyrites, the composition of the mineral may be stated thus:

		Oxygen ratio.	
Silicic acid	63.06	31.53	3
Protoxide of iron	24.60	5.46	1
Magnesia	11.74	4.70	
Soda and potassa	.31		
	99.71		

It is therefore a tersilicate of protoxide of iron and magnesia, Fe Si+Mg Si.

The composition of the nickel iron approaches very closely to—

Fe	86.00
Ni	14.00

a peculiar alloy which appears to be very common in meteor masses.

Another large stone of this same fall, weighing 20 pounds, was described by Shepard.[4] He says:

The following statement concerning it is from a letter of Rev. R. Gaylord, of Hartford, Iowa, dated July 3, 1850. "It was found (in the summer of 1847) in Hooshier Grove by Abner Cox. He was in company with John Hollis, of whom

I obtained two fragments three years ago. They have had the stone two years or more, and by lying in the loft of a smoky cabin it is somewhat dingy in appearance. This John Hollis is the man who ground up so much of the stones that were seen to fall in order to get silver. He was the means, however, of the careful preservation of the present mass. Dr. Knight found they had the stone and wrote me respecting it.

"The three pieces into which it broke in striking the ground fit together exactly, so as to reproduce the original stone, with a complete coating over the whole, except on one side, where several small fragments were broken out by the fall. These were gathered up carefully and preserved by the finder."

The stone is perhaps the most remarkable one thus far described, for its highly regular prismatic figure which at once suggests the idea of a portion of a basaltic column. Nor can the geologist look upon it without feeling almost certain that it once formed part of some extensive formation in the world from whence it came. Two surfaces of the stone, which are nearly flat, agree in presenting a peculiar wavy, undulating surface and a deeper black color than belong to the other faces of the stone, a difference which appears to originate in the nature of the horizontal cleavage as contrasted with the oblique or vertical. The greatest diameter of the base is 10.25 inches.

The fragments from a cliink at the top are rich in chlorine, deliquescing freely with chloride of iron when exposed to a moist state of air; while the rest of the stone is quite free from this constituent, and precisely resembles the other stones of the locality already described. This difference of composition in one and the same stone is probably owing to the fact that the fragments in question must have remained for a considerable time partially buried in the soil and have imbibed the chlorine from thence; while the main mass being above ground and more protected by its coating was preserved from such impregnation.

In 1853 Shepard [6] gave a cut of the 2.5-pound stone.

Rammelsberg [7] gave an account of the meteorite as follows:

This meteorite fell on February 25, 1847, its total weight being about 65 pounds. Shepard described the fall and made a mineralogical and chemical examination of the stone.

According to his statements it consists of 10.4 nickel iron, which contains about 14 per cent nickel; 5 per cent magnetic pyrites, and 83 per cent of a unique, homogeneous silicate, which he called howardite. This silicate, before the blowpipe, melts readily to a black, scoriaceous glass, is decomposed by hydrochloric acid with the separation of flocculent silicic acid, and consists of:

		Oxygen ratio.	
Silicic acid	63.06	33.63	
Iron protoxide	24.60	5.4	10.17
Magnesia	11.74	4.70	
Alkali	.31		
	99.71		

Since the proportion of oxygen equals 1:3.3 the howardite was more acid than a trisilicate.

It is evident that these data of Shepard's are in a high degree problematical. The ready fusibility and decomposability of so acid a silicate is extremely exceptional.

G. Rose placed this meteorite among the chondrites and remarked that it was very like the one from Mauerkirchen.

I obtained a piece of this meteorite from Professor Shepard. The mass is very friable and contains flakes of rust, and indeed the outer crust appears brown. By pulverizing, only a very small quantity of metallic iron can be perceived. and it appears that the greater portion thereof is changed into oxide or oxyhydrate. Indeed, the stone, after heating, gives off no inconsiderable amount of water.

According to the analysis, on account of the evident partial alteration of the nickel iron, it is not possible to definitely determine the latter (the nickel iron). The powder was treated with hydrochloric acid for the silicic acid and the magnesia; the iron content required by the olivine mixture was estimated, but the remainder of the latter was reckoned as metal.

After loss of 1.84 per cent by heating it gave:

Iron	9.46	10.54	89.75		
Nickel	1.08		10.25		
			100.00		
Iron	4.05	6.37 FeS			
Sulphur	2.32				
					Oxygen
Silica acid	16.24	41.85	38.80		
Iron protoxide	8.92		21.31	4.74	20.7
Magnesia	16.69		39.89	15.96	
			100.00		
Undecomposed	41.24				
	100.00				

The olivine was not far from—

$$\left.\begin{matrix}Fe_2SiO_4\\3Mg_2SiO_4\end{matrix}\right\}$$

The undecomposed silicate, whose amount is almost equal to that of the olivine, consists of:

Silica	55.08	....	29.38
Alumina	4.86	....	2.27
Iron protoxide	13.58	3.02	13.15
Magnesia	22.70	9.08	
Lime	2.85	0.81	
Soda	0.93	0.24	
Potash	trace		
	100.00		

The whole is therefore almost exactly a bisilicate.

The proportionate composition of the silicate (amounting to 83.09 per cent of the meteorite) is as follows:

Silica	46.88
Alumina	2.40
Iron protoxide	17.49
Magnesia	31.36
Lime	1.41
	99.54

It is evident that this result bears not the least resemblance to the data obtained by Shepard.

Iowa (Linn County) is a chondrite.

Brezina [9,10] classed the meteorite as veined white chondrite, and says:

The large mass in Tübingen of 432 grams weight has a crust and is nearer Cia than Cwa. A small fragment of the collection of Kunz is strongly marked with metallic veins, one of which is laid bare as an armor face.

The meteorite is distributed, Amherst having the largest mass (21 pounds, 6 ounces). This is probably the large stone described by Shepard.[4]

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MARSHALL COUNTY.

Marshall County, Kentucky.
Latitude 36° 50′ N., longitude 88° 20′ W.
Iron. Medium octahedrite (Om), of Brezina; Caillite (type 18), of Meunier.
Found ?; described 1860.
Weight, 6.8 kgs. (15 lbs.).

This meteorite was described by Smith,[1] as follows:

A piece of this meteorite was sent me from Marshall County (Kentucky). I have not yet seen the entire mass, which is said to weigh 15 pounds and to be scaly in structure. It has the usual characteristics of meteoric iron as seen from the analysis:

Fe	Ni	Co	Cu	P	
90.12	8.72	.32	trace	0.10	=99.26

Brezina [3] described the structure as follows:

Finely granular; kamacite somewhat puffy; polyhedral troilite grains or plates in the kamacite. Breadth of bands, 0.8 mm.

Meunier [4] gave the following description:

Has the structure and composition of the caillite type, but with less geometrical regularity in the etching figures. At certain points the tænite laminæ are very close together, elsewhere they are relatively distant; the kamacite bands are quite large and plessite is remarkably scarce.

Cohen [5] noted that the iron took on a more or less permanent magnetism.

The meteorite is distributed, Amherst having the largest mass (6 pounds).

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Marshall County, 1893. See Plymouth.

MART.

McLennan County, Texas.
Latitude 31° 31′ N., longitude 96° 45′ W.
Iron. Fine octahedrite (Of) of Brezina.
Found 1898.
Weight, 7,144 grams (15.75 pounds).

This meteorite was described by Merrill [1], as follows:

The second meteorite to be described, which will be known as the Mart Iron, was found early in 1898, on the farm of H. T. Vaughan, near Mart, in McLennan County, Texas.

This iron weighed originally 15.75 pounds. From it a slice weighing 456 grams was cut for the collection of the National Museum, the iron having been donated by the finder to the museum of Baylor University, at Waco, Texas. For the privilege of removing this slice we are indebted to Mr. O. C. Charlton, curator of the museum. The original shape of the iron was that of an irregular oval, somewhat flattened at one side and rounded above, with two large and deep pittings on the broader surface. The original dimensions were about 8.5 × 15 × 25.5 cm. It was not seen to fall and had evidently lain in the soil some time, as the exterior was considerably oxidized and the troilite, which presumably once occupied the pits, was completely eliminated. Small dark points on the etched surface are due to troilite. Sundry cracks in the iron at various points on the etched surface are also filled with troilite which frequently oxidizes in process of etching. Mr. Tassin, by whom the etching was done, calls attention to the perfection of the Widmannstätten figures, and particularly to the relief of the tænite bands.

As shown by this etching, the iron belongs to the octahedral variety, and is of moderately coarse crystallization. Its general appearance is so similar to that of the Hamilton County (Texas) iron described by Howell as to suggest that it may be a part of the same fall. The probability is still more evident when it is considered that the two localities are not over 50 miles apart in a straight line.

The chemical evidence, as shown by a comparison of Mr. Eakins's analysis of the Hamilton iron with that of Doctor Stokes, is, however, not favorable to this view, though we believe the possible (if not probable) variation in composition in different parts of the same iron has not yet been fully worked out.

	Mart.	Hamilton Co.
Fe	89.68	86.54
Ni	9.20	12.77
Co	0.33	0.63
Cu	0.037	0.02
P	0.158	0.16
S	0.017	0.03
C	.....	0.11
Chromite	trace	.....
Fe_2O_3	trace	.....
	99.422	100.26

The samples submitted were cut from the outer portion of the meteorite, including the oxidized crust; this was carefully removed by scraping and filing. There was a small quantity of rust in the cracks on the cut surface, but its amount was trivial.

During the solution in aqua regia scales of schreibersite were observed. A few small black grains were left which showed crystal faces under the microscope, and which were identified as chromite by the usual reaction. A minute amount of colorless granular matter was also noted, the nature of which could not be determined.

All determinations were made in a solution of the same portion of 3.8536 grams, the residue having been brought into solution and added.

The analysis gave:

	0.9659 gram.	1.9318 grams.
Fe	89.68	.....
Ni	9.20	.....
Cu	.....	0.037
Co	0.33	.....
P	.....	0.158
S	.....	0.017
Cr	.....	trace
	99.422	

From the above data the composition of the iron may be expressed as follows:

Nickel-iron (Fe, Ni, Cu, Co)	98.31
Schreibersite	1.06
Troilite	0.05
Chromite	trace
Fe_2O_3	trace
	99.42

The mass is chiefly preserved in Baylor University, Waco, Texas.

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Maverick County. See Fort Duncan.

MAZAPIL.

Zacatecas, Mexico.
Latitude 24° 31′ N., longitude 101° 59′ W.
Iron. Medium octahedrite (Om) of Brezina.
Fell 9 p. m. November 27, 1885; described 1887.
Weight, 3,950 grams (9 lbs.).

The first description of this meteorite seems to have been by Hidden [1], as follows:

Among the large number of meteoric irons which have been described only eight are recorded as having been seen to fall. It is my privilege to be able to add a ninth fall to this short list and one which may prove to be of exceptional scientific importance. This mass of meteoric iron I received in August last as a gift from my friend, Prof. Jose A. y Bonilla, director of the Astronomical Observatory at Zacatecas, Mexico. He stated that it was seen to fall at about 9 p. m. on November 27, 1885, during the periodical star shower of the "Bielids." Such is the great interest of this meteorite as shown by its history that I have delayed announcing it until the evidence of its fall had been substantiated as thoroughly as possible.

The general freshness of surface, which shows very perfectly the flow of the melted crust; the presence of unusually large nodules of a very compact graphite; the very slight superficial oxidation, and its dissimilarity to other meteorites of the region, are all interesting features of this iron, and serve to confirm the statement of its recent fall. When received it weighed about 3,950 grams. Its present weight is 3,864 grams. Its greatest length, diagonally across the mass, is 175 mm. In its thickest part it measures about 60 mm. It could be described as a flat irregular mass covered with deep depressions and having a smooth surface.

The evidence of the fall is set forth in the following communication (translated) from Professor Bonilla:

"It is with great pleasure that I send to you the uranolite which fell near Mazapil during the night of November 27, 1885. That you may the better appreciate the great scientific interest which this uranolite possesses I will state that everything points to the belief that it belongs to a fragment of the comet of Biela-Gambert, lost since 1852. I

here give you the history of this celestial wanderer. On December 2, 1885, I received to my great delight from Enlogio Mijares, who lives on the Conception Ranch, 13 km. to the east of the town of Mazapil, a uranolite, which he saw fall from the heavens at 9 o'clock on the evening of November 27, 1885. The fall, simply related, he tells as follows in his own words:

"'It was about 9 o'clock in the evening (November 27, 1885) when I went to the corral to feed certain horses, when suddenly I heard a loud sizzing noise, exactly as though something red hot was being plunged into cold water, and almost instantly there followed a loud thud. At once the corral was covered with a phosphorescent light and suspended in the air were small luminous sparks as though from a rocket. I had not recovered from my surprise when I saw this luminous air disappear and there remained on the ground only such a light as is made when a match is rubbed. A number of people from the neighboring houses came running toward me and they assisted me to quiet the horses which had become very much excited. We all asked each other what could be the matter, and we were afraid to walk in the corral for fear of getting burned. When in a few moments we had recovered from our surprise, we saw the phosphorescent light disappear, little by little, and when we had brought the lights to look for the cause, we found a hole in the ground and in it a ball of fire (*Una bola de lumbre*). We retired to a distance, fearing it would explode and harm us. Looking up to the sky we saw from time to time exhalations or stars, which soon went out, but without noise. We returned after a little and found in the hole a hot stone, which we could barely handle, and which on the next day looked like a piece of iron; all night it rained stars, but we saw none fall to the ground as they seemed to be extinguished while still very high up.'

"The above is the simple recital of the ranchman, and the uranolite which fell is the one I send you. From the numerous questions I have asked Sr. Mijares, I am convinced that there was no explosion or breaking up on falling. Others who saw the phosphorescence, etc., were Suz Sifuentes, Pascual Saenz, Miguel Martinez, and Justo Loperz. Upon visiting the place of fall, I was particular to examine the earth in and around the hole, and by careful search and washing the earth I found a few small bits of iron, which must have become detached from the uranolite when it penetrated the earth.

"The hole was 30 cm. deep. Probably the light which was seen came from the volatilization of the surface of the celestial body due to the high temperature acquired by friction with the atmosphere, and of this volatilized matter falling to the earth as an incandescent powder."

The above communication was followed by an account of the observation of the Biela meteors at Zacatecas by Professor Bonilla and his assistants. The locality of the fall is situated in latitude 24° 35′ N., and in longitude 101° 56′ 45″ W.

The surface of the Mazapil iron is of great interest.

The deeply hollowed depressions entirely cover the mass. A thin black crust coats the surface, and exhibits well the striæ of flow, as seen on meteorites whose fall has been observed. In 11 places nodules of graphite are noticed extruding from the surface, one of which is nearly an inch in diamteer. The graphite is very hard and apparently amorphous; troilite and schreibersite were also observed on a section of the iron. The lines of the Widmannstätten figures are somewhat similar to those of the Rowton iron in their width and distribution, and are very unlike the known Mexican irons from Toluca, Durango, Coahuila, etc.

In its surface and general flatness the mass bears a remarkable resemblance to the Hraschina, Agram, iron which fell May 26, 1751. In weight it is nearly equal to the irons of Rowton (7.75 pounds), Charlotte (9.5 pounds), Victoria-West (6 pounds 6 ounces), and Nedagolla (9.75 pounds), which were all seen to fall.

Analysis by J. B. Mackintosh:

Iron	91.260
Nickel	7.845
Cobalt	0.653
Phosphorus	0.300
	100.058

Carbon is distributed all through the iron between the crystalline plates, and this element was also observed with the spectroscope in the "Bielids," of November 27, 1885. Chlorine is also present and shows itself by a slight deliquescence. Where the crust has been accidentally removed the lines of the Widmannstätten figures can be seen without the aid of etching. The interest of this meteorite, because of its beautifully marked and fresh surface, is enhanced by the concurrence of its fall with the shower of the Biela meteors.

The report of the directors of the Zacatecas Observatory to Hidden is given in full by Brezina,[2] but contains no new facts of importance regarding the meteorite itself.

The meteorite is somewhat distributed, but is chiefly preserved (3,546 grams) in the Vienna collection.

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2. 1895: Brezina: Wiener Sammlung, pp. 282–283 and 308–327.

Mecklenberg County. See Flows.

MEZQUITAL.

Durango, Mexico.
Here also San Francisco del Mezquital.
Latitude 23° 42′ N., longitude 104° 19′ W.
Iron. Nickel-poor ataxite, Siratik group of Brezina.
Known shortly before 1868; described 1868.
Weight, 7,513 grams (16 lbs.).

The history and characters of this meteorite have been given in condensed form by Cohen,[10] as follows:

This iron was described by Daubrée [1] in 1868, under the name San Francisco del Mezquital. According to Burkart[3] and Fletcher,[7] the place, which lies 10 leagues south of Durango in the district of Mezquital, is now called simply Mezquital, and the longer name, given by the missionaries, is found only upon old maps. It seems to me more appropriate, therefore, to designate the place of discovery by the now generally current name of Mezquital.

According to Daubrée,[1] the mass brought from Mexico by General Castelnau and weighing 7 kg., had a very characteristic flat form; being only 7 cm. in thickness. Of the three principal surfaces the smallest was almost even, the other two had a more or less irregular surface. Upon one surface was found an almost round saucer-like depression 2 cm. deep and 8 to 9 cm. in diameter; a part of the surface appeared to be shagreened, an effect traceable to atmospheric influence. Daubrée was inclined to conclude, from the form of the mass, that the nickel-iron had taken shape after the manner of a vein inside a stony mass, a view which was first expressed by Haidinger respecting Netschaëvo. Troilite, according to Daubrée, occurs in Mezquital in a threefold form; in veins 7 cm. long by 2 mm. thick, in round grains, and in cylindrical particles, of which latter only the hollow impression is preserved. The appearance upon etching is rather indistinctly described; on the one hand, very indistinct Widmannstätten figures were said to arise; on the other hand, by careful examination, long laminæ of schreibersite and a little rhabdite were said to stand out upon a background of granular nickel-iron. Damour determined the specific gravity as 7.835 at 11° C., and furnished the following analysis; that for the nickel-iron being calculated (2) after extraction of the schreibersite;

	Fe	Ni	Co	P	
1:	93.38	5.89	0.39	0.23	= 99.89
2:	94.06	5.57	0.37	....	=100.00

Meunier [2] investigated the behavior of a polished surface under etching with quicksilver chloride and explained the marks arising therefrom as Widmannstätten figures; later he ranged Mezquital under the caillite group, which is composed of a mixture of kamacite and tænite. In 1893,[4] however, he classed it among the imperfectly characterized meteoric irons, and emphasized the fact that no figures were produced by etching with acid. He mentioned in this place that the troilite grains are enveloped with graphite and schreibersite. In 1889 [6] he described a peculiar alteration-product of the original crust; this crumbled to a powder, 79.30 per cent of which consisted of magnetite, while the remainder was composed of small, sometimes transparent, grains with easy fracture in two directions, which were insoluble in water but readily soluble in nitric acid and were to be regarded as a nickeliferous basic sulphate resembling copiapite.

In 1885 Brezina [5] referred Mezquital to the octahedral irons with fine laminæ; later, however, the piece in question proved to be Cambria. In 1895 [9] he identified the true Mezquital (obtained from the British Museum) with the Chesterville group. According to Brezina's description, the iron is partially traversed by zigzag, smooth-faced fissures, and shows—like Chesterville—in a glittering groundmass, besides isolated schreibersite lamellæ, somewhat elevated etching ridges which are arranged according to different systems of parallel planes. The swollen lamellæ easily break through the fine particles of the groundmass. A film between two such lamellæ is of somewhat porous constitution.

Fletcher [7] also emphasized the absence of Widmannstätten figures. According to him, after etching with bromine glistening straight lines running parallel over the entire surface of 130 by 70 mm. come out, with interspaces of 1 to 2 mm.; the etched surface resembles that of Coahuila.

A piece weighing 18.9 gr., with three section surfaces at right angles to one another of about 4.2 and 1 sq. cm., shows, especially after rather strong etching, a distinctly granular structure, since it is composed of irregularly bounded granules 0.125 to 0.25 mm. in size, frequently overlapping, with jagged edges, every part of which shows the same oriented sheen. Independent of these granules, four fine stripes traverse the iron upon the two largest surfaces; they arise from the combination of the swollen lamellæ, which, however, are so small that they can only be distinctly perceived with a strong glass. According to my view and that of Fletcher, they run parallel, but Brezina gives an arrangement according to different systems of parallel planes. The stripes follow one another at distances of 2 to 3 mm. and the flat-formed portions between contain, in larger or smaller number, similar small swollen-formed elevations, sometimes closely packed together, sometimes more loosely distributed or even isolated; Brezina speaks of a somewhat porous character of this portion, but I find no evidence of it in an investigation with the microscope. While the piece was only slightly etched, I, like Brezina, regarded the swellings as elevations produced by etching; after stronger etching, however, there appeared

in places swellings apparently composed of nickel-iron, shiny granules, splinters, or variously formed, streaked structures of 0.01 to 0.07 mm. in size. I regard them as schreibersite, which, after weak etching, remained coated with a thin film of nickel iron. It is evident from this that the nickel-iron in immediate proximity to the before-mentioned granules is affected less readily by the acid than the less fine grained groundmass. At all events there lies in one place a group of rhabdite needles up to 1 mm. in length, each one of which is surrounded by a smooth, shiny etching zone about 0.05 mm. wide. There are, besides, grains 0.5 to 1 mm. in size and isolated, columnar crystals of schreibersite also up to 3 mm. in length in considerable numbers, which, however, show no sort of regular arrangement. A few grains contain a grain of troilite, which is doubtless accompanied by daubréelite; the dimensions are too small for a more exact determination.

According to the structure of the principal part of the nickel-iron, and under the assumption that Damour's analysis is trustworthy, Mezquital belongs to the granular ataxites poor in nickel. It is distinguished from the Chesterville meteorite which is of almost the same granular and chemical make-up, by the arrangement of the swellings in layers, which in the latter iron are distributed evenly over the entire etching surface. I would assent to this grouping also, if the "lay" of the swellings was oriented according to faces of the hexahedron.

Later Cohen[11] gave an analysis by Fahrenhorst, as follows (specific gravity, 7.7687):

Fe	Ni	Co	Cu	Cr	S	P	
93.36	5.46	0.87	0.03	0.00	0.15	0.16	=100.03

From this he deduced the mineralogical composition:

Nickel iron	98.55
Schreibersite	1.04
Troilite	0.41
	100.00

The meteorite is chiefly (7,120 grams) in the possession of the British Museum.

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Miller's Run. See Pittsburg.
Milwaukee. See Trenton.

MINCY.[a]

Taney County, Missouri.
Here also Crawford County, Forsyth, Miney, Newton County, and Taney County.
Latitude 36° 35′ N., longitude 93° 12′ W.
Mesosiderite (M); Logronite (type 31), of Meunier.
Found about 1856; described 1860.
Weight, 90 kgs. (197 lbs.).

The first published mention of this meteorite seems to have been by Shepard,[1] under the title "Forsyth (Taney County, Missouri)", as follows:

My first information of this locality was derived while on a visit to southeastern Missouri in April last (1860), from N. Aubushon, Esq., of Ironton. He stated that a small specimen of curiously knitted, malleable ore of a white color resembling silver, had been sent him two or three years ago by a person residing near the locality. Mr. Aubushon forwarded it to an assayer at Ducktown, Tennessee, from whom he learned that it was composed of iron and nickel. On

[a] The spelling Miney was given by many writers, but the correct spelling is Mincy.

visiting St. Louis soon after, I was informed by Professor Swallow, the state geologist, that a specimen had also been transmitted to him by letter from the same place; and that Professor Litton had found it to be composed of similar constituents. Professor Swallow presented me a small fragment of his specimen, upon which I am able to offer a few remarks, awaiting the results of Professor Litton's analysis, for fuller information.

The mass evidently belongs to the rather rare group of amygdaloidal meteoric irons in which, like those of Steinbach (Saxony) and Hainholz (Westphalia), the peridotic ingredient preponderates over the nickeliferous iron. Its specific gravity is 4.46. The iron is remarkable for its whiteness, while the peridote is of a well-marked green color, and distinctly crystalline. No pyrites is visible in the very small fragments examined. It is reported that two considerable masses of this meteorite were found buried in the soil of a hillside; and that they are at present secreted under the belief that they contain silver.

In 1865 mention was made in the American Journal of Science of the receipt by J. Lawrence Smith [3] of a piece of the meteorite as follows:

Prof. J. Lawrence Smith has received a portion of a new meteorite from Arkansas, consisting of mixed iron and stony matter, which he has under investigation.

Under the title of the "Newton County, Arkansas," meteorite Smith[4] gave a detailed description as follows:

The first notice of the meteorite of Newton County was made in 1860 by Professor Cox, who was engaged in the geological survey of Arkansas. The original has not been obtained; the only fragment of it being in the hands of Judge Green, was given to Professor Cox, who has kindly presented it to me. The weight of the fragment is 22.5 ounces, and was evidently broken off from one corner of the mass, as it presents three of the original surfaces.

This meteorite is of the mixed variety, and can not be classed with either the metallic or stony meteorites; it is one of the most interesting that has been discovered in the United States, differing from any other that has yet been found in these regions.

The stony matter is very distinctly crystallized, and some of the minerals can be easily detached and examined separately. The metallic portion constitutes somewhat over one-half of the mass, and owing to the diffusion of the stony matter has a coarsely reticulated structure.

When broken under the hammer, and the iron separated by the magnet, it is obtained in coarse grains varying from 3 to 4 grains down to very small fragments. The exterior is of a rusty color, roughened by projection of nickeliferous iron, and over several parts of the surface there is a white incrustation.

Specific gravity taken on different species varies from 4.5 to 6.1. By mechanical means and the aid of a magnet, the following minerals were separated:

Nickeliferous iron.	Hornblende.
Chrome iron.	Olivine.
Sulphuret of iron.	Carbonate of lime.

Nickeliferous iron.—I may as well mention the manner in which I separate the iron from the stony matter of meteorites. In most instances it is necessary to sacrifice a fair portion of the specimen. The mass is crushed in a steel mortar. The magnet is then able to take out the iron from the mass of stony matter, especially if the crushing operation is repeated two or three times. The iron is then introduced into an iron or, better still, a silver capsule or crucible, and a strong solution of potash added. Heat is applied until all the water is driven off, and the residue is heated to redness. On cooling water is applied, and the excess of potash washed out, as well as some silicate of potash that is formed. After thoroughly washing the particles of iron they are moistened with a little alcohol, and dried on blotting paper with a gentle heat; and by holding a magnet a little distance from them the particles of iron will adhere to the magnet, almost perfectly free from earthly matter.

The iron, if of a coarse reticulated structure, as the one in question, may require to be crushed in the steel mortar after treatment by potash, to detach particles of silicate remaining in small crevices; and in this variety I sometimes repeat the treatment by potash. In this way the foreign matter associated with the iron can be reduced to one half per cent. Of course this process sacrifices more or less of the iron, especially if the iron be in very small particles. But this sacrifice is of secondary importance compared with the necessity of having the metallic matter in a pure state. Thus purified the iron was found to be composed of:

Iron	91.23
Nickel	7.21
Cobalt	.71
Copper, Phosphorus	too small to be estimated.
	99.15

In the analysis, after separating the iron by the acetate of soda, the nickel and cobalt were separated by nitrate of potash; which method I have used frequently and with the best results. Liebig's method of accomplishing the same end has been much improved by the modification lately devised by Professor Gibbs, of dissolving the oxide of

mercury in the cyanide of mercury. But having every arrangement necessary for executing successfully the method by the nitrate of potash, I have not yet tried Professor Gibbs' modification, but shall do so shortly.

Chrome iron.—This is found in small quantity in minute particles, some of them showing distinct faces of crystals; but I failed to find any complete octahedron. The quantity was too small for analysis, but was readily recognized by the blowpipe.

Sulphuret of iron.—This also is discernible only in minute quantity, and could not be collected for analysis. I would remark, with reference to the sulphuret of iron found in meteorites, that it can not be classed with the terrestrial magnetic pyrites, whose formula is considered Fe_7S8, having always found the sulphur too small for this formula; in which conclusion I believe I am sustained by Rammelberg and others. My results point to the formula FeS; and if the composition of these two kinds of pyrites be correctly made out, then the meteoric variety has no terrestrial representative.

Hornblende.—This mineral is easily separated, and is of a greenish-gray color, more or less soiled by iron. With some care it can be detached unmixed with other constituents. It has a very distinct cleavage in one direction and an imperfect one in another. On analysis it gave:

Silica	52.10
Alumina	1.02
Protoxide of iron	16.49
Protoxide of manganese	1.25
Magnesia	29.81
Alkalies (potash, soda, lithia)	.24
	100.91

The oxygen relations of the silica and protoxides furnish the formula R_4Si_3—the formula of hornblende. In structure and composition it is not unlike varieties of anthophyllite.

Olivine.—This mineral is diffused through the mass. Some of the smaller pieces are almost colorless; others again are more or less yellow, being stained with oxide of iron. Some of the fragments are iridescent, like varieties of oligoclase, which I at first took it to be. Sufficient of it was detached in a pure state for analysis, and was found to be composed as follows:

Silica	42.02
Alumina	.46
Protoxide of iron	12.08
Magnesia	47.25
	100.81

There was a minute quantity of the manganese estimated with the oxide of iron and magnesia. This analysis overruns the 100. This is accounted for in part by the quantity used for analysis not being more than 0.160 grams. The oxygen ratio of the silica and protoxides show the composition R_2Si, which is that of olivine.

Carbonate of lime.—The observation of this constituent in a meteorite is something entirely new, yet it is found on the exterior surface of the meteorite in question, in various places. There is no doubt in my mind, however, that this ingredient was no part of the mass when it fell, but that it has been exposed to certain conditions since its fall by which carbonate of lime has been incrusted on its surface.

It is much to be regretted that the entire original mass is not accessible to furnish facilities for determining whether it is an incrustation or not, and if the former, whether the incrustation was formed prior to or subsequent to the fall.

In relation to the presence of carbonates in meteorites, we have first the and only announcement up to the present time, in connection with the meteorites which fell at Orgueil in 1863. Messrs. Des Cloizeau, Pisani, Daubrée, and Cloez discovered minute rhombohedral crystals of double carbonates of magnesia and iron.

Wadsworth[5] described the two meteorites separately. Forsyth, Taney County, Missouri, he classed as a pallasite,

composed of a white, sponge-like mass of nickeliferous iron containing greenish olivine, the latter being more abundant than the former. Specific gravity, 4.46.

Newton County, Arkansas, he described as

a coarsely reticulated or sponge-like mass of iron, containing in its cells olivine and enstatite(?). Chromite and pyrrhotite also occur. The enstatite is of a greenish-gray color and more or less stained by the iron. The olivine is in part colorless and in part stained yellow by the oxide of iron. The analysis does not afford data from which to give the composition of the rock as a whole. The specimens seen indicate that it is closely allied to the peridotites, but probably belongs with the pallasites with which it is here placed.

The discovery of the exact locality of the meteorite and the correlation of the different accounts was due to Kunz.[7] His account is in part as follows:

During June, 1887, a meteoric mass came into my possession, and through the kindness of Miss Hattie Payne, of Lamar, Arkansas, I learned that it was taken about thirty years before from a spot in latitude 36° 35′ N. and longitude

93° 12′ W. of Greenwich, near Mincy, Taney County, Missouri, 11 miles southeast of Forsyth, and over 60 miles from Limestone Valley, Arkansas. Miss Payne also stated that about thirty years ago a meteorite passed over the boundary line between Arkansas and Missouri and was supposed to have fallen near by. After considerable search it was believed to have been located on a farm 11 miles southeast of Forsyth, whence it was taken 60 miles to a farm in Limestone Valley, Newton County, Arkansas, on the supposition that it was of value. As it was decided not to be of meteoric origin, however, it remained unnoticed for 28 years, except that a few gun sights were made from it by some of the curious neighbors. A portion of it was sent to the writer and he at once secured the balance of the mass. It measures 34 by 35 by 29 cm. and at the smaller end is 12 cm. high. Its weight is 197 pounds (89.796 kg). It is similar to the Hainholz, Westphalia, iron, is one of the Syssidéres of Daubrée and of the Logronite group of Meunier. Two large crystals of olivine are present, one measuring 10 by 8 cm. and another 4 by 6 cm.; this part being so much lighter in color than the rest of the mass and so much more easily detached that the larger crystal has been almost entirely picked out to a depth of 5 cm. At one corner of the mass there is an inclosure of augite measuring 7 by 4 cm. This is gray and granular in structure and has all the appearance of a common gray pebble inserted in the iron. The surface of the meteorite is deeply pitted and in many places traces of a black crust are still visible; the pitting measures 1 to 4 cm. across. On one side a fungoid growth has slightly stained it green. Microscopic sections were made and in these it was seen that the olivine did not occur in separate crystals, but rather in aggregations of irregularly-shaped grains surrounded by brown ferruginous veins and with banded anorthite grains interspersed here and there. These aggregations are full of black microlites, glass masses, and needle-shaped clear crystals, and are imbedded in the metallic iron without any border of alteration. The boundary line is perfectly sharp, fresh, and distinct, in which characteristic it differs from the meteorite of Powder Mill Creek. The olivine appears to be fresh, but is clouded with the brown ferruginous stains abundantly scattered through it and between the grains. The following analyses were kindly furnished me by Mr. J. Edward Whitfield and were made before its identity with the Newton County, Arkansas, meteorite was suspected. He says:

"The analyses of the metallic portion is as follows:

Fe	89.41
Ni	10.41
Co	.29
P	.16
	100.27

"Of the rocky portion I have made an analysis of the whole part, i. e., not separated as soluble and insoluble but with the metallic part separated. The analysis is as follows:

SiO_2	45.88
Al_2O_3	7.89
FeO	19.73
CaO	6.02
MgO	17.96
NiS	1.67
FeS	0.54
	99.69

"From the nickel and sulphur and iron we have the percentage corresponding to the formula (Ni,Fe)S, for the troilite.

"Taking the piece as it was received the specific gravity is 4.484. Of the finely ground rocky portion, free from metallic particles as far as possible, I have made quite a number of analyses to learn the nature of the insoluble mineral, and as far as I can judge it is enstatite only and the soluble part is a lime-iron silicate with considerable Al_2O_3. Of the insoluble in dilute hydrochloric acid the following is the analysis:

SiO_2	52.39	=	.87	
Al_2O_3	7.11			
FeO	14.68	=	.20	.81
CaO	4.49	=	.08	
MgO	21.33	=	.53	
	100.00			

"Ratio of SiO_2 : R″O=.87 : .81 which agrees pretty well with enstatite; but here the MgO is replaced by as much FeO and the presence of Al_2O_3 makes the ratio vary a little from the normal 1 : 1. Deducting all the S as NiS and the Fe to correspond to the remaining S from the soluble part we have for the percentages of the soluble the following:

SiO_2	26.95
Al_2O_3	17.69
FeO	35.98
CaO	15.98
MgO	3.40
	100.00

"The little MgO here probably comes from the slight solubility of the enstatite."

A review of the literature of the subject is then given by Kunz, and he concludes that the different descriptions refer to parts of one and the same meteorite which originally fell near Mincy, Taney County, Missouri. In this conclusion he has been followed by later authorities.

Brezina [8] in his 1895 catalogue gave the following observations concerning the meteorite:

This mass is peculiar because of the rôle which the nickel iron plays. It occurs in isolated grains resembling iron chondri, and varying in size up to 6 cm. These chondri, especially the larger ones, from 1.5 cm. diameter upward, are not solid, but have in the interior vermiform cavities filled with masses of silica and grains of iron. After etching, also, the compact iron chondri show merely a granulation similar to that of brecciated hexahedrites, although the individual grains of iron are seamed with tænite bands. These iron chondri are cut off sharply at the groundmass and seldom pass over into this. The structure of the entire mesosiderite is very coarse grained. The groundmass is likewise besprinkled with grains of iron which have mostly a diameter of 1 to 2 mm.; in this groundmass are found olivine crystals from 1 to 5 cm. in size, generally of a pinkish-brown, less frequently of a greenish gray, or leek-green color; besides outcroppings from 1 to 10 cm. in size of crystalline chondrites, sometimes free of iron, sometimes shot through with dust-like particles of iron which occasionally contain a larger grain of iron. Occasionally the large olivine crystals are surrounded by a space poor in iron. Troilite occurs but seldom.

Meunier [9] classed Mincy as logronite, the characters of which are as follows:

Rock with stony minerals predominating, inclosing abundant and at times numerous metallic grains. The whole is traversed by a metallic network. The stony part is very crystalline and in places constituted of shining lamellæ. The metallic portion is also very crystalline. The rock takes a good polish. As regards mineralogical composition the iron grains appear to consist chiefly of kamacite and tænite. Some schreibersite may also be seen. The stony portion consists of a mixture in which a mineral resembling olivine predominates, and with it are acid silicates resembling pyroxene.

Mincy is distributed, but the main mass (39 kgs.) is in the Vienna Museum.

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Missouri, 1839. See Little Piney.

MISTECA.

State of Oaxaca, Mexico.
Not Yanhuitlan.
Latitude 16° 45′ N., longitude 97° 4′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1804.
Weight unknown.

This meteorite seems to have been hopelessly confused with Yanhuitlan, both in literature and in collections. It seems probable that the two masses occurred near together, and as their etching figures resembled one another they were not distinguished for a long period.

Brezina [13] in 1895 was the first to urge their separation, opposing the view of Fletcher,[9] who thought that they should be regarded as one. Brezina's statement is as follows:

Misteca belongs, in consequence of the width of its lamellæ, 0.8 to 1.2 mm., near the coarse octahedrites. Castillo, and with him Fletcher, regarded it probable that the Misteca meteorite had been cut from the Yanhuitlan mass. The difference in the structure of the irons quite excludes such a possibility, however.

It seems correct therefore to separate Misteca and Yanhuitlan, the one as a medium and the other as a fine octahedrite, but to learn the separate history of each seems impossible at present.

The first mention of Misteca as a meteorite locality seems to have been by Del Rio [1] in 1804. He gives "La Misteca" as a locality for metallic iron. A piece of meteoric iron acquired by Partsch in 1834 for the Vienna Collection is described as "from an Indian town in the Misteca, State of Oaxaca, Mexico." He states that it was brought from Mexico by Freiherr von Karawinsky, of Munich.

Bergemann [3] gave the following analysis (specific gravity, 7.58):

Fe	Ni	Co	P	S	Insoluble	
86.875	9.917	0.745	0.070	0.553	0.975	=99.135

Rammelsberg [6] obtained different values, as follows:

Ni	4.39
Co	0.18
Insoluble residue	0.20

The discrepancy between these two analyses is marked and shows an error somewhere. A new analysis of an undoubted Misteca specimen is desirable.

Buchner [5] described the structure of the iron as follows:

Upon a freshly broken surface this specimen shows an almost silver-white color, a granular-flaky structure, and a very distinct crystalline texture, while on other portions of the natural surface it is iron-black and covered with bubbly, drusylike cavities from the size of hazelnuts to that of walnuts, which are covered over with a thin, firm material of the color of brown iron ore. Inside, the mass is homogeneous, without clefts or cracks, and without visible admixture of sulphide of iron or other foreign substances, the sulphide of iron first becoming noticeable after etching. By etching, very beautiful Widmannstätten figures come out, whereby also the admixture of sulphide of iron and phosphide of nickel-iron become visible, first in fine round portions, and, as it appears, less frequent than in the irons of Zacatecas and Xiquipilco. The bands of the figures are 0.25 to 1 line wide, hatched with fine, diagonally intersecting lines, and likewise dotted with fine white specks upon a gray background. The bands are divided from one another by narrow, bright, brass-colored borders of a metallic luster, which also occur sometimes in the central areas, not, however, in continuous, but in broken and interrupted lines. They evidently consist of schreibersite. These border lines appear most distinctly upon continuous surfaces against the bright brown or blue background, by reason of their beautiful yellow color, where one also sees much more distinctly the middle areas circumscribed by such edges and hatched with broken and often only dotted lines, which here and there approach so near again that the whole middle portion appears yellow.

Meunier [12] described the structure as follows:

This is one of the irons which give the most perfectly characteristic figures of the caillite type. The kamacite, in medium bands, has a granular structure which takes on a sort of watered appearance upon etching. Tænite is present in extremely fine and continuous filaments. The plessite presents the same sort of combs and gratings. The specimen in the Paris Museum does not contain an appreciable quantity of pyrrhotine. Schreibersite is found in the residue after dissolving.

The distribution of the meteorite is impossible to determine until it can be separated from the Yanhuitlan specimens.

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Mitchell County. See Waconda.

MOCTEZUMA.

Sonora, Mexico.
Latitude 28° 49′ N., longitude 109° 40′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1899; undescribed.
Weight?

This meteorite is mentioned by Berwerth [1] and Ward,[2] but no description is given except the data given above. Ward states that the main mass is in the collection of the School of Mines of the City of Mexico.

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MODOC.

Scott County, Kansas.
Latitude 38° 33′ N., longitude 101° 5′ W.
Stone. Veined white chondrite (Cwa) of Brezina.
Fell 9.30 p. m. September 2, 1905; described 1906.
Weight. Fifteen to twenty stones, weighing in all about 16 kgs. (35 lbs.).

The first scientific mention of this meteorite was by Merrill [2] as follows:

A hitherto unreported meteorite fall took place on the night of September 2, 1905, about 9.30 p. m., in Scott County, Kansas. The fall was attended with the usual explosion, light, and sound, variously compared to cannonading and the roll of heavy wagons.

Thus far 14 pieces of the stone have come to light, the largest of which, weighing 4.61 kg., is at present in the National Museum. A broken surface shows the stone to be indistinctly chondritic, of a very light gray color, and under the microscope is found to consist essentially of olivine and enstatite, with a very small amount of plagioclase feldspar. It evidently belongs to Brezina's group of veined chondrites (Cwa), and will be known as the Scott County meteorite.

A further note was published by Farrington [3] as follows:

Investigation has been made by the writer of the meteorite fall which took place at Modoc, Scott County, Kansas, about 9.30 p. m. September 2, 1905. Mention of the fall was made in the local paper at the time and in Science of March 9. The phenomena of the fall were observed by a large number of the inhabitants of Scott and the adjoining counties. The course of the meteorite, as learned by the writer through inquiries in several counties, was nearly due east. The phenomena were a sudden lighting up of the sky by a swift-moving fireball "as big as a washtub" which quickly exploded with three successive and widening discharges. The explosion must have occurred not far from Tribune, Greeley County, Kansas, since the interval between light and sound there was but a few seconds. The fall of stones, however, occurred at Modoc, about 40 miles farther east, the interval between light and sound there being between two and three minutes. It would appear, therefore, that after the explosion the stones traveled about 40 miles before reaching the earth, at a velocity of about one-third of a mile per second. Up to date 13 fragments and individuals have been found, the heaviest having weighed 11 pounds. The other individuals and fragments found range in weight from 7 pounds to a few ounces. The area over which they were scattered is one of about 7 miles in length by 2 miles in width, extending nearly due east and west, the larger stones being found at the east end of the area. The principle that the smaller stones would fall first is thus corroborated. The stones appear to be of the type of white or gray chondrites and to have the usual composition of meteorites of this character. They are coated, for the most part, with a thick black crust, although considerable breaking up took place in the atmosphere, so that some fragments have only a secondary crust or none at all. The total weight of individuals thus far collected is 32 pounds.

Merrill [4] gave the following further account:

The meteoric stone described below was received at the National Museum from Mr. J. K. Freed, to whom we are indebted for the facts given relative to its fall and the privilege of describing it.

The stone fell on the night of September 2, 1905, about 10 p. m., and seems to have come from the west or southwest. When about 6 miles due west of Scott City it exploded with what is described as a terrific roar, plainly heard for a distance of 25 miles, awakening those who had already gone to sleep and frightening people for miles around. Its appearance when exploding was variously described as like the "headlight of a locomotive," and a "white light as big as a haystack afire." Eighteen miles south of Scott City it is stated to have been light enough to "pick up a pin." Following the explosion was a noise compared with the discharge of a heavy battery of artillery or of a heavy wagon running rapidly over the frozen ground, the noise gradually dying away like rolling thunder in the distance. Some claim to have heard the whistling of rocks through the air like bullets or heavy hail. Mr. Freed himself compares the sound to that of "a mighty swish-h-h, resembling the sound of a skyrocket."

After a search extending over a period of more than a year 14 pieces have been reported as found, scattered over an area some 2 miles by 7 in the vicinity of Modoc, a small town on the Missouri Pacific Railroad. These were mostly complete individuals. Three and a fragment received at the National Museum weighed, respectively, 4640, 1170, 490, and 110 grams. Two others obtained by Dr. O. C. Farrington for the Field Columbian Museum are reported as weighing about 5,400 grams. An individual of approximately 2,000 grams weight is reported as in the hands of a collector in Kansas. This accounts for 7 out of the 14 reported finds. It seems safe to assume that the weight of the entire fall could not have been less than 15 kilograms.

The 4.64 kg. individual received at the museum was the largest thus far reported. Its dimensions are: Height over all, 21 cm.; maximum width, 15.5 cm.; thickness, 10.65 cm. This was found several miles east of the others and was embedded but 4 or 5 inches in the hard buffalo-grass sod, inclining slightly to the west. It is a complete individual, with the exception of a small fragment of about an ounce weight, which had been broken away to send to the museum previously for examination.

This and the others examined are covered with a dull brown-black, slightly rough crust of approximately a millimeter in thickness, showing no traces of flow structure nor perceptible thickening in any part such as would indicate the position of the block in its flight through the air. The surfaces are, on the whole, rather free from pittings. Sundry darker streaks running parallel with the broader faces suggest a lack of homogeneity or a possible fissuring of the mass.

The broken surface shows the stone to be very indistinctly chondritic and of a color even lighter gray than the Mōcs or Drake Creek, Tennessee, stone which it closely resembles. With a pocket lens abundant metallic points are visible.

Under the microscope the stone is found to consist essentially of olivine and enstatite in characteristic jumbled, granular crystalline forms, interspersed with larger irregular granules and indistinctly outlined chondri of the same material, together with blebs of metallic iron and troilite. As already noted, the chondritic structure is quite inconspicuous on a broken surface, the individual chondri consisting of irregularly rounded, oval, and sometimes angular aggregates of olivines in granular and gratelike forms, or enstatites in eccentric radiating masses, in either instance the interstices being often occupied by a colorless mineral identified as feldspar. In a single instance a chondrus was noted consisting of a coal-black dustlike material interspersed with a few blebs of troilite, the whole being nearly surrounded by the colorless zone of feldspar (?), the appearance in an ordinary light being practically identical with the black chondrus from the meteorite of Chateau Renard, as figured by Tschermak. The mineral identified as a plagioclase feldspar occurs in small perfectly clear and colorless interstitial forms, so lacking in crystalline outline and cleavage as at first to suggest a residual glass. Extinction angles are quite unsatisfactory, the dark waves sweeping across the face of the crystals in a manner indicative of a condition of strain; and, were it not for an occasional particle with inconspicuous twin bands, the real nature of the mineral would be in doubt. It was, unquestionably, the last mineral to crystallize, is quite free from inclosures, and occupies the interstices of the olivines and enstatites, often partially enwrapping them, very like a glass, but between crossed nicols polarizing faintly in light and dark colors and breaking up into granular masses comparable with the secondary feldspars in the drusy cavities of metamorphic rocks. Aside from occurring between the bars and radiating columns of the chondri, as already mentioned, it is scattered throughout the ground in a manner closely identical with that of the Milena meteorite, as also figured by Tschermak.

As noted above, the stone is traversed by fine threadlike black veins, though how abundant such may be it is impossible to tell without breaking the specimen, and this the writer has not been able to obtain permission to do.

The fall adds one more—the twelfth—to the remarkable list for which Kansas has become noted.

As will be seen from the description, the stone belongs to Brezina's group of veined chondritic meteorites (Cwa). It will be known as the Modoc, Scott County, meteorite.

CHEMICAL ANALYSIS, BY WIRT TASSIN.

The native metal was determined in 2.0255 grams of the crust-free meteorite as follows: The finely pulverized material was treated in the cold with a solution of mercuric ammonium chloride, in an atmosphere of hydrogen. The results were:

Fe	6.56
Ni	0.68
Co	0.034

The sulphur was determined in 1.0300 grams of the meteorite, after fusion with $Na_2CO_3+KNO_3$. This yielded:

S	1.38

The phosphorus was estimated in 1.0450 grams, and the percentage found was:

P	0.051

The soluble silicates were determined by treatment with HCl, sp. 1.06. The action was allowed to take place on the water bath and continued but two hours. The acid then decanted off and the operation twice repeated. This treatment gave:

SiO_2	17.38
FeO	10.95
Al_2O_3	0.20
CaO	0.14
MgO	17.73

The insoluble silicates were determined after fusion with Na_2CO_3. The alkalies were necessarily determined in a separate portion. Chromite was not present.

SiO_2	26.75
FeO	4.42
MnO	0.10(?)
Al_2O_3	2.27
CaO	1.60
MgO	8.72
K_2O (present but not determinable).	
Na_2O	0.44

The general composition of the portions of the meteorite analyzed, as derived from the combination of the several determinations, is:

Fe	6.56
Ni	0.68
Co	0.034
S	1.38
P	0.051
SiO_2	44.13
FeO	15.37
MnO	0.10 (?)
CaO	1.74
MgO	26.45
Al_2O_3	2.47
K_2O	Trace.
Na_2O	0.44
	99.40

The mineralogical composition of the meteorite may be approximately calculated from the above summation. The amount of nickel-iron is determined directly; troilite and schreibersite are calculated from the amounts of sulphur and phosphorus found, assuming that schreibersite has the formula Fe_2NiP. The soluble silicate is olivine. The insoluble silicates are regarded as enstatite and the feldspathic mineral noted, the amount of alumina found furnishing the basis for the calculation:

Nickel-iron	4.59
Troilite	3.79
Schreibersite	0.34
Olivine	46.40
Enstatite	29.94
Other insoluble silicates	14.36
	99.42

It must be confessed that the last item in the calculation is not wholly satisfactory, the 14.36 per cent of other insoluble silicates not being accounted for in the microscopic examination. It undoubtedly includes the feldspathic constituent and presumably also a portion of the irresolvable matter of the chondrules. A like condition of affairs was noted by Borgström in his description of the Shelburne meteorite, which, from a chemical standpoint, this closely resembles.

The specific gravity of the Modoc stone was determined on two complete individuals, weighing 1,110 and 490 grams, respectively, by a large apparatus constructed on the plan of the beam balance recommended by Penfield in the latest edition of his Brush Determinative Mineralogy. No attempt was made to exhaust the air from the pores, the stone being immersed in water and, with frequent agitations, allowed to remain until no more bubbles were given off. The average of two determinations was 3.54.

Farrington[5] gave the following further account:

This meteorite has already been made the subject of a brief note and detailed study by Merrill and a note by the present writer. Some additional facts obtained by the writer during a visit to the locality in February, 1906, and by study of specimens seems worthy of record. These observations include accounts of the phenomena of fall obtained from various residents of Modoc, also at Tribune, 40 miles west of Modoc. The accounts at the latter place show a much shorter interval to have intervened between light and sound than at Modoc. This seems conclusive evidence that the meteor exploded over Tribune and traveled about 40 miles before falling. The accounts here given are arranged in the order of the position of the observers going eastward.

Mr. Raines, the station agent at Tribune, was about to lower a curtain at an east window when he saw the meteor at the north going eastward. Its appearance was that of a ball of fire, resembling an electric light in color and of the size of a "washtub." In a short space of time, probably two or three seconds, it exploded, throwing out sparks and then disappeared, leaving no trail behind it. In about 30 seconds three muffled reports and a continuous roar like thunder were heard.

Mr. P. W. Grimes, of Tribune, was sitting with his head down, facing west, when a light like that of an electric light attracted his attention. He saw a ball of fire to the north, traveling east. The light lasted two or three seconds, and in about 20 seconds came three muffled reports like those of thunder.

Mr. Willie Baugh was driving south about 2 miles from Modoc. He saw a light to the west, resembling an electric light, seemingly falling toward him. Then it seemed to describe an upward path and exploded, sparks going in different directions like those of a Roman candle.

Mr. and Mrs. W. E. Curtis, of Modoc, had retired for the night when Mrs. Curtis was awakened by a light so bright that she thought the barn was afire. This light was followed by three reports like thunder and a sound like the wind coming up. She awakened Mr. Curtis, who went to the porch, and then heard sounds like hailstones falling. The fall of each stone was accompanied by slight hissing sounds. Next morning Mr. Curtis found a stone weighing about 1 pound in his yard, and others later.

Mr. and Mrs. Fred Yost, living only a few rods from Mr. Curtis, heard a sound like accentuated thunder, but saw no light nor heard any stones falling. They found several stones about their premises later.

Mr. Schirmeyer, of Modoc, was indoors. He saw a light at an east window and stepped out on the porch to examine it. Two or three explosions like rifle shots followed, also swishing sounds like the dropping of stones. Rumbling sounds then died away to the west for about five minutes.

Mr. Irwin, of Modoc, saw a light below a partially lowered curtain. He called to his wife to see what was going on. She got up for a moment and then retired again; and then came sounds which led them to think that a smashup had occurred on the railroad near by.

Mr. T. D. Marshall was coming up out of his cellar at the time of the fall. His attention was attracted by a bright light in the sky, which was followed by a sound like four beats on a bass drum and others like the swish which accompanies the shooting of a rocket. He then heard stones striking in a number of places about his house. He expected to be able to find a number of these the next morning, but on searching succeeded in discovering only one.

Mr. McDonald heard sounds like the firing of a machine gun, and a few days later found a small stone about 100 feet from his house.

Mr. J. K. Freed heard sounds like those of a machine gun.

Inhabitants of Scott, about 4 miles east of the place of fall, generally described the sounds as like those of a wagon traveling over a bridge.

An account of the occurrence published in the local paper, the Scott County Chronicle, September 8, 1905, six days after the fall, was as follows:

"Last Saturday night about 10 o'clock a remarkably bright meteor was seen in the heavens west from this city. It was almost as light as day. The explosion occurred in the vicinity of Modoc and was heard clear across the county. T. D. Marshall had a piece of the meteor in town Wednesday which he found near his house, which is black on the outside and gray on the inside, and is heavily charged with metal indicating silver and gold. It is reported that W. E. Curtis and a man named Pence have found pieces that show that the remnants were scattered over several miles of territory. Mr. Marshall says the commotion in his territory was simply terrifying."

Under Modoc items an account was given in the same paper as follows:

"Last Saturday night about 9 o'clock a meteor passed over this locality. It was followed by a roar that sounded like thunder. It probably burst, as fragments were heard falling by several persons, and T. D. Marshall and W. E. Curtis each found one. The parts found were dark lead color, almost black, and give a metallic sound when struck. They are checked by small cracks indicating an extremely heated condition while passing through the air. They weigh but a few ounces, yet are prized by the finders as they probably represent part of some planet far away, and have traveled for millions of miles through space before finding a resting place on earth."

The difference in time of these two accounts is accounted for by the fact that in Modoc, mountain time is used, but in Scott, central time.

The area over which the meteoric stones were found was one about 7 miles by 2, the longer distance extending east and west. The region is a rolling prairie, rather thinly inhabited. Much of the area has never been plowed. The native sod, or "buffalo sod," as it is often called, proved comparatively impenetrable to the stones which fell upon it. A slight indentation in the sod showed plainly where a stone weighing 7 pounds, found by the writer, had

struck. The ground also was bare at that point, showing that the grass had been killed. The meteorite did not lie at the point where it had struck, however, but about its own width (4 inches) to the south. It had thus evidently bounced southward on striking. Mr. McDonald, of Modoc, informed the writer that the stone which he found had also bounded southward. Mr. Freed, of Modoc, informed the writer that the stone which he found had penetrated the sod about 4 inches. This was of tabular form and was on edge. It weighed 11 pounds.

The following list shows the individual stones which had been found at the time of the writer's visit and the names of the finders. All of these masses were seen by the writer. The weights are in several cases approximately only. Those that are known accurately are given in grams.

	Weight.	*Finder.*
1.	10.75 lbs. (4,640 grams)	J. K. Freed.
2.	7 lbs. (3,171 grams)	O. C. Farrington.
3.	5 lbs.	F. P. Heller.
4.	2 lbs. 10 oz. (1,170 grams)	F. P. Heller.
5.	1 lb. 15 oz. (879 grams)	F. P. Heller.
6.	1 lb. 6 oz. (624 grams)	John March.
7.	1 lb. 1 oz. (490 grams)	Fred Yost.
8.	14 oz.	— McDonald.
9.	12.5 oz.	W. E. Curtis.
10.	10 oz.	T. D. Marshall.
11.	6 oz.	Fred Yost.
12.	6 oz. (170 grams)	Fred Yost.
13.	6 oz.	Mrs. W. E. Curtis.

In addition the find of an individual weighing 1.5 pounds was reported by O. L. Douglass, and one weighing 2 pounds by F. P. Heller. Thus a total of at least 15 stones has been found, having an aggregate weight of about 35 pounds (16 kg.).

The distribution of these specimens over the area in falling shows a remarkable gradation in accordance with their size. The stones fell in order of their weight from west to east. This is graphically shown in a plate. The two individuals weighing 1 pound and 2 pounds each, found in the vicinity of the 5-pound mass, are fragments, the remaining portions of which were not found although extended search was made, and the region is exceptionally favorable for searching for meteorites. The smooth buffalo sod has no other stones upon it and the vegetable growth is not sufficient to hide stones of appreciable size. These fragmentary individuals are shown in a plate. The complete individuals would probably weigh about 5 pounds each. Some of the noncrusted surfaces of these show blackening while others are perfectly fresh. The completely encrusted individuals are of irregular, angular shapes, with angles slightly rounded, as is usual in meteorites. Several, however, show projecting spurs of toothed form which are unusual. No. 10 is especially notable for these. The three views given of this individual show its orientation. The broad surface (shown in a plate) with rounded shallow pits was the rear side, the opposite the front side. As shown by the side view, the individual is fragmentary.

The individual found by the writer has a roughly tetrahedral form with one of the faces of the tetrahedron broken up into three planes. The faces are nearly all slightly concave and show only a few broad pittings. A marked feature of the surface is a whitish deposit occurring on several of the faces. This deposit is more or less streaked in appearance, and the direction of the streaks is such that they would meet in a common point if produced. Examined under a lens the deposit is seen to be a fine powder embedded in the interstices of the slaggy crust. It is soluble without effervescence in hydrochloric acid, but is so small in quantity that further determination of its nature can not be made. The simplest explanation of its origin would seem to be to regard it an efflorescence due to weathering, as the meteorite had been exposed five months to the elements when found. The uniformity of direction of the streaks is somewhat difficult to account for on this hypothesis, however. One of the uppermost faces, moreover, is entirely free from the deposit. The deposit lies on what was undoubtedly the forward portion of the meteorite in falling and the radiation of the streaks from a common point suggests that it was made during flight. In either case the phenomenon is new to the writer's experience. The individuals shown in another plate were, as already stated, fragments when found, and no adjoining parts have yet been discovered in the vicinity so far as the writer is aware. The encrusted portion of one is seen to be deeply pitted, the pits varying in form and size on the different surfaces. On one surface they are abundant, small, and uniformly distributed, on others fewer in number, larger, and deeper. The complete individual was evidently of tabular form and about 2 inches (5 cm.) thick. One of the broad surfaces is remarkably flat and shows well-marked divergent lines of flow on the crust. The other individual illustrates the internal veins which occur in some specimens. These veins are evidently only armor faces produced by slipping. They are planoid in character and run in various directions which often intersect. The crust of most of the individuals is dull and coal black in color, though of reddish tone in some individuals. Crackling of the crust into irregular polygonal areas is a common and characteristic feature, as shown in several of the plates. The crackle has a meshlike pattern with meshes in the form of polygons, squares, and triangles from 0.25 to 0.5 inch on a side. The appearance is entirely similar to that presented by crackled earthenware and is doubtless produced by shrinking of the crust in cooling or expansion of the interior of the meteorite subsequent to the formation of the crust. Another interesting feature seen on the crust of several individuals is that of glazed spots of occasional occurrence. The spots are usually of a greenish color, oval

to circular in area, and vary from 0.25 to 0.5 inch in diameter. They doubtless mark the location of chondri of fusible composition.

Under the microscope, the crust shows in cross section a thickness of about 0.5 mm. The three zones of Tschermak are plainly marked, with widths averaging as follows: Fusion zone 0.025 mm., absorption zone 0.1 mm., impregnation zone 0.4 mm. These zones exhibit the usual characters, the fusion zone being black, opaque, and glassy, the absorption zone transparent, and the impregnation zone showing a large proportion of black, opaque matter. The relative widths above given remain fairly constant, although in places the absorption and fusion zones are of about equal width, and again, the absorption zone may disappear altogether. The fusion zone is at times also blebby and rough in outline. The interior of the meteorite is megascopically ash gray in color, in some individuals flecked with rusty spots. The substance is only fairly coherent, and will not polish.

The meteorite is somewhat distributed. The Field Museum collection possesses 4,513 grams.

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Monmouth County. See Deal.

Monroe. See Flows.

Monroe County. See Forsyth.

Morelos. See Amates.

Morgan County. See Walker County.

MORITO.

Chihuahua, Mexico.
Here also El Morito and San Gregorio.
Latitude 27° 53′ N., longitude 105° 40′ W.
Iron. Medium octahedrite (Om), of Brezina; Caillite (type 18), of Meunier.
Known since 1600; mentioned 1619.
Weight, 11,000 kgs. (24,250 pounds).

A mention by Cordoba [1] of the discovery of a mass of iron by Oñate in 1600 is regarded by Fletcher [13] as referring to this meteorite. This mention is as follows:

They (Oñate's expedition) reached the farthest villages on the border of New Biscay, where there is a tradition of the Indians that, when they were coming from New Mexico to people the Old, their deity in the form of an aged woman placed there a remarkable landmark of seemingly more than 800 quintals (hundredweight) of iron, whereupon some returned to their mother country and some went on to people new Spain. And, for their boundary and peace, they were divided by this wondrous landmark, set up in a desert, in latitude 27° 30′ N., and as lustrous as refined silver. * * * They (Oñate) marched with great toil. * * * and in seven (7) months they reached the province they were making for.

Another early account of the meteorite is quoted by Fletcher [13] from Salmeron,[3] as follows:

There is also an old tradition among the Indians that a lump of metallic iron, which is 3 leagues distant from Santa Barbola (sic), and half a league away from the road to New Mexico, is a memorial of the coming of the Mexicans to people this country (Old Mexico); and that they halted near there, and that the idol which used to speak to them told them that it would tarry at the place as a memorial. The iron must weigh upwards of 8 hundredweight (quintals), and they say that a deity, in the form of an Indian woman, aged, and wrinkled, used to draw it along. How remarkably strong the old Indian woman must have been! It is an object which all who pass along this road go and look at as a curiosity. A blacksmith of Santa Barbola (sic) severed a bit from one side; and others, not believing it to be an object that could have been moved and dragged from a distance, but suspecting it to be (the outcrop of) a mine of native iron, made an excavation beneath it. On the removal of the earth by which it was supported, the mass turned over on one side, and it is in that position at the present day.

Hardy [2] described the mass as follows:

From Real (Rio) del Parral to the hacienda of Santa Cruz is 12 leagues; 9 leagues farther on the same road is the town of San Gregorio, where there is an enormous mass of iron and nickel, perhaps the meteorite which Mr. Humboldt describes as being near the town of Durango. Real del Parral had formerly a population of fifty or sixty thousand souls and was very celebrated in its day, which has now gone by. Many attempts have been made to melt down this mass of iron, but without success. An Italian imagined that by heating one side of it he should be able to cut off as much of the metal as he wanted. Accordingly, he piled on the part where he intended to commence his operations an immense quantity of wood, to which he set fire, and by dint of united blast of five or six forge bellows he succeeded in giving it a red heat which indeed was so insupportable that, to his astonishment, he could not come near it. However, I am told that by applying a wall of thick boards before him he succeeded in obtaining 3 pounds of iron; which 3 pounds cost him $130 and they were not worth $4.

Burkart [4, 5, 6] made several inquiries for the mass, chiefly in order to determine whether it was the iron referred to by Humboldt as the Durango iron. He concluded, however, that it was not. In 1871 he[7] obtained a more complete description of it, which he published as follows:

Mr. Weidner has sent me some information regarding the iron meteorite of the Hacienda la Florida and Mr. Damm some pieces of the meteorites of San Gregorio and Concepcion, obtained by Mr. Stallforth in Parral. Since these are the first pieces of these which have yet been obtained in Europe I have given them to Professor Rammelsberg in the hope that he will analyze the material and publish the results. With the pieces were sent some information from which I draw the following: The meteoric iron of San Gregorio which W. H. Hardy saw and mentioned in his book on Mexico has not been previously described nor are details given regarding its size, weight, and appearance. Also the notices by Messrs. Porras and Urquidi give nothing. The former says that the mass must have fallen 7.5 leagues from the hacienda of San Gregorio. No one knew when it was found, but it must have been long ago, since at the beginning of the previous century the "stone of iron" laid bare by the rain was chosen as a boundary between the Villa de Alende and the hacienda San Gregorio. About 50 years ago the owner of the latter brought the mass to his court and, according to Hardy an Italian, and according to Porras, a blacksmith, made fruitless efforts to separate a piece by fire, in consequence of which the well-known inscription (see below for translation) was placed upon it:

Solo Dios con su poder
Este fierro destruirá,
Porque en el mundo no habrá
Quien lo puede deshacer. A° 1828.

This is on the side at present lying east. The mass has, besides a depression the size of a head in the middle, other smaller ones toward the edges as if made by fingers with long nails.

Burkart [9] further gives the account of Urgindi, which is quoted below.

Fletcher [13] notes that—

Exactly the same account of revelation by a heavy rain, within a short distance from the hacienda, was given for the Concepcion mass in 1871, by the actual owner and yet it is now established that the mass had been removed from near Huejuquilla in 1780; there is almost exactly the same tradition relative to the attempt to cut large pieces from the two masses.

Smith [8] described it as follows:

This immense mass of meteoric iron is situated on the western border of the Mexican desert. It measures 6 feet 6 inches in its greatest length, is 5 feet 6 inches in height, and 4 feet thick at its base; on one part of its surface, 1821 is cut with a chisel, and above this date is the following inscription: "Only God with his power can destroy this iron, for no one on the earth will ever be able to shatter it."

It lies within the inclosure of a hacienda, having been hauled to the ranch many years ago by the Spaniards, who thought that it could be made use of as iron for farming utensils. It is said to have fallen quite near its present site and from its huge bulk and weight, which is calculated at above 5 tons, it could not have been transported very far. Nothing more is known of its history.

Small specimens were detached by Doctor Butcher, one of which I have examined. I find it to be of the softer meteoric irons, with a specific gravity of 7.84. The fragment I possess is too small for the study of the true character of its Widmanstätten figures. Upon analysis it furnished the following composition:

Fe	Ni	Co	Cu	P	
95.01	4.22	0.51	trace	0.08	=99.82

Juan Urgindi,[9] in a letter to Professor Henry of the Smithsonian Institution, stated that he had seen the San Gregorio meteorite twice in 1856. He further states:

It is larger than the one at this place (Hacienda Concepcion) and seems to consist of the same material, has very much the shape of a sofa, and bears an inscription which reads thus (translated):

"Only God with his power
This iron will destroy,
For the world will have
No one able to divide it in pieces."

In my opinion this meteorite and the one we have here are fragments of another much larger one that probably burst at a sufficient height from the earth to cast one piece on this hacienda, another one on that of San Gregorio, 10 leagues to the northwest, and other larger ones on Chupaderos, 20 leagues to the northwest of this place.

Huntington [11] remarked the octahedral character of the meteorite and stated that it must be placed in a different class from the Coahuila irons.

Castillo [12] described the meteorite under the title of the Hacienda of San Gregorio. He states that this hacienda is situated 13 km. northwest of the Valle de Allende. He further says:

The form of the meteorite is nearly that of a cone 1 m. high and 1.2 m. in diameter at the base. Its density being 7.74, its weight becomes 11,560 kgs. Like the preceding (the Chupaderos meteorites) it is riddled with holes or cylindrical cavities, in part filled with troilite. It fell at the place called El Morito 4.5 km. from the Hacienda of San Gregorio, and the proprietor in 1600?, Mr. Raphael de Pastrana, transported it to the court of this hacienda, where it is to-day (1889).

Fletcher [13] gave a full account of the mentionings of the meteorite by travelers, including Humboldt. He regards it possible that it may have been the Durango mass mentioned by Humboldt. He also expresses the opinion that the meteorite is of the same fall as Chupaderos and Concepcion (Adargas). He also quotes from what is probably a letter from J. D. Knotts, of Parral, as follows:

Mr. J. D. Knotts, of Parral, states (1890) that, according to local traditions, the mass was moved some 130 to 140 years ago to the hacienda of San Gregorio from El Morito, about 2 leagues distant in an easterly direction. About four or five years since it was moved by the present owner from the center to the corner of the hacienda, a distance of 70 feet, by 50 men with levers, in order to form part of the house.

Meunier [14] classed the meteorite as Caillite, and described the Paris specimen as follows:

The specimen in the museum is not perfect, it having been twisted when it was separated from the mass from which it came. Nevertheless, it gives the characteristic figures of caillite. No pyrrhotine is to be seen, but schreibersite is not rare.

Brezina,[15] in 1895, seems to have been the first to use the name Morito for this meteorite. He classed it as a medium octahedrite, and described it as follows:

Morito (San Gregorio) is the old landmark which originally lay at El Morito, 4.5 km. from the Hacienda de San Gregorio, with the date "1600" chiseled upon it; it was then brought to the hacienda by the proprietors, 13 km. Northwest from the Valle de Allende, where it still lay in the year 1889. The weight has been estimated now at 800, now at 250 quintals (40,000 to 12,500 kgs.; according to Castillo 11,560 kgs.). The iron has the form of a highly oriented cone 1 m. in height by 1.2 m. in basal diameter. The conical surface is covered with groovelike depressions running from the apex, while the base is quite flat. Two small pieces from the Schulz collection show straight, strongly bunched lamellæ 0.9 mm. thick. The tænite is scarce, fields absent, and kamacite much spotted, resembling Descubridora, Adargas, Misteca, and Pila (Durango). It has a zone of alteration along the natural exterior surface 0.2 to 1.5 mm. in thickness. Fletcher seems to regard Morito as belonging with Adargas, Rio Florido, Chupaderos, Sierra Blanca (Toluca), and Tule (Toluca), but I do not think this permissible. More exact analyses of the Mexican irons are very much to be desired.

The meteorite is preserved almost entire in the School of Mines of the City of Mexico.

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MORRISTOWN.

Hamblen County, Tennessee.
Here also the Safford meteorite and Hamblen County.
Latitude 36° 14′ N., longitude 83° 32′ W.
Iron-stone. Grahamite of Brezina.
Found 1887; described 1893.
Weight, 16 kgs. (36 lbs.).

This meteorite was first described by Eakins [1] as follows:

This meteorite which was found in September, 1887, on a ridge about 6 miles west-southwest from Morristown, Hamblen County, Tennessee, was first recognized and brought to notice by Prof. J. M. Safford, who, in course of an inspection of a collection of iron ores, recognized some fragments as undoubtedly meteoric. Prof. Safford at once took steps to secure these pieces and visited the locality where they were found. Here he succeeded in finding a few more fragments, which had the appearance of having been buried in the soil and afterwards turned up by the plow. These various pieces now in Prof. Safford's possession have a total weight of about 36 pounds, two of them weighing respectively 11 pounds and 13 pounds. A specimen sent by Prof. Safford to the United States National Museum, and now in its collection furnished the material for this investigation. Most of the pieces show much surface oxidation, a fresh fracture showing a gray color with numerous metallic particles of nickel-iron. The analysis was made in the usual way for this class of meteorites; that is, by separating the metallic and siliceous portions, both by picking and by the magnet and analyzing separately the nickeliferous iron, the silicates soluble in hydrochloric acid, and those insoluble. The metallic and siliceous portions of this meteorite are approximately equal in amount, the iron being quite malleable and unusually tough. The analysis is as follows:

Nickeliferous iron.

Fe	Ni	Co	Cu	P	S	
90.92	7.71	0.80	trace	0.19	0.04	=99.66

Siliceous portion.

	Soluble in HCl.			Insoluble in HCl.		
	Analysis.	Calculated to 100%.	Molecular ratios.	Analysis.	Calculated to 100%.	Molecular ratios.
SiO_2	16.79	45.61	0.760	31.47	50.67	0.844
Al_2O_3	8.33	22.62	0.222	9.25	14.89	0.146
Cr_2O_2	....	....	....	0.82	1.32	0.009
FeO	4.88	11.73	0.163	6.55	10.55	0.147
NiO	0.39	1.06	0.014	....	....	....
MnO	....	....	....	0.47	0.76	0.010
CaO	5.19	14.09	0.252	2.24	3.61	0.64
MgO	1.34	3.64	0.091	11.16	17.98	0.449
KO	....	....	....	0.02	0.03	....
Na_2O	....	....	....	0.12	0.19	0.003
P_2O_5	0.46	1.25	0.009	....	....	....
S	0.25	....	....	....	....	....
	37.63	100.00	.....	62.10	100.00	.....

In calculating the analysis of the soluble portion to 100 per cent, the S and an amount of iron (0.56 per cent FeO) sufficient to form FeS are first deducted. In many stony meteorites olivine is a considerable constituent, generally forming the bulk of the soluble silicate; but in this case the analysis shows olivine to be present in but small proportion, if at all. It is interesting to note that both the soluble and insoluble portions have practically the same molecular ratios, the soluble portion reducing itself essentially to RAl_2SiO_6 in which R=CaFe; and the insoluble part to the same formula where R=MgFe, both being equivalent to aluminous enstatite or pyroxene. At the time this analysis was made it was impracticable to supplement the work with the proper microscopical examination of sections, which doubtless, in conjunction with the chemical evidence, would have satisfactorily determined the minerals present. Without this microscopical knowledge, however, little that is definite can be said except that there seem to be present two similar molecules; the one in which lime predominates being soluble, and the other, magnesian,

being insoluble in hydrochloric acid. The other alternative is to assume a complex molecule which is split into two sections by the action of the acid.

The meteorite is now known as the Safford meteorite.

The results of Eakins were referred to by Merrill,[2] and further examination of the meteorite reported by him as follows:

Three specific gravity determinations, made on fragments from 15 to 25 grams in weight, including both iron and stony portions, yielded the present writer an average of 4.32.

In thin sections the structure of the stony portions is found to be holocrystalline granular, sometimes strongly cataclastic. This latter structure is particularly conspicuous in those portions rich in metallic iron, where the feldspars are often inclosed in the form of sharply angular fragments in the iron or in its numerous embayments. The appearance is not, however, that of a clastic rock, but rather that of a crystalline variety which has been subjected to dynamic agencies. The structure as a whole is quite irregular and, as above noted, porphyritic through the presence of large pyroxenes which at times are 5 to 8 mm. in diameter.

The groundmass of the stone is composed mainly of granules of pyroxenes and plagioclase of such size as to render their determination by the microscope a matter of considerable ease, but which are interspersed with innumerable rounded and irregular granular forms so minute and so lacking in crystal outlines as to render their true mineralogical nature a matter of conjecture only.

The feldspars as a rule show polysynthetic twinning. Sections without twin striæ (and which are assumed to be parallel approximately to $\infty P \infty$, show the emergence of an optic axis just outside the field, and give extinction angles as high as $-38°$, suggestive of anorthite. By means of a specific gravity solution a small quantity of the feldspar (0.19 gram) was separated out and analyzed with the results given below, and which confirm the result of the optical determination. They usually contain a large number of cavities and inclosures in this respect and with respect to their shattered condition as well, resembling those of the Sierra de Chaca stone.

The analysis of the feldspar is as follows:

SiO_2	Al_2O_3	FeO	CaO	MgO	Na_2O	
42.02	37.77	trace	16.41	0.96	Undt.	=97.16

Two pyroxenic minerals are present. The one of a gray color, owing to minute cavities and dustlike inclosures, and giving in all cases extinctions parallel and at right angles with the evident cleavage; microchemical tests show the presence of magnesia but not of lime or alumina. It is hence assumed to be enstatite. The second is very clear and pellucid, of a faint greenish tinge, though without evident pleochroism. It shows an imperfect prismatic cleavage, a pronounced parting parallel to $\infty P \frac{1}{\infty}$ has at times somewhat fibrous or platy structure, and gives extinction on P, measured against cleavage lines, running as high as 30°. Granules of this mineral isolated for microchemical tests were insoluble in hydrochloric acid. With hydrofluoric acid on a slide first covered with hard balsam they dissolved, yielding abundant rhombs of magnesian fluosilicate. The solution treated with a drop of dilute sulphuric acid yielded gypsum needles, and with cæsium chloride and sulphuric acid abundant minute, more or less modified octahedra of cæsium alum. The mineral is, therefore, assumed to be diallage, though the angle of extinction is small. Olivine is quite inconspicuous, and were it not for the magnesia in the soluble portion of the stone would be quite overlooked. It seems to exist intergrown with the enstatite and can not be isolated. The powdered rock after being passed repeatedly through a solution of sufficient density to separate the feldspar still yields a small amount of gelatinous silica, the acid solution reacting for both magnesia and lime, suggesting the presence of monticellite. It is possible, however, that the lime may have come from inclosures of anorthite too small to be recognizable.

Repeated attempts were made at separating the two pyroxenes for complete analysis, but the variation in density was too slight to permit this, even when the silver-thallium nitrate solution was employed.

Inasmuch as the presence of the minerals above noted, as determined microscopically, did not satisfy all the requirements of the analyses of the soluble portions, further qualitative and microchemical tests were resorted to. It was found that merely boiling the pulverized stone for a few minutes in distilled water was sufficient to give a solution reacting for chlorine, sulphuric acid, lime, and iron. These reactions, considered in connection with the minerals known to occur in meteorites, are sufficient to suggest, if not prove, the presence of gypsum as an oxidation product of oldhamite and of lawrencite. The phosphoric acid suggests schreibersite, and the odor of sulphuretted hydrogen given off by the boiling solution, troilite. Instead of, then, attempting to account for the result of the analyses on the assumed presence of two minerals having practically the same molecular ratios, as was done in the paper above quoted, the present writer would suggest the following as the probable mineral nature of the stone, including the metallic portion:

(1) Nickeliferous iron.
(2) Enstatite.
(3) Diallage.
(4) Anorthite.
(5) Olivine (or monticellite).
(6) Oldhamite (or secondary gypsum).
(7) Lawrencite.
(8) Troilite.
(9) Schreibersite.

According to the prevailing system of classification the stone must be called a mesosiderite; viewed from the standpoint of terrestrial petrography, it would be classed as a gabbro with gradations toward pyroxenite.

A few words more may well be written concerning the structure of the stone. This, as above noted, is crystalline granular throughout, no glass whatever being detected. In the finer-grained siliceous portions the constituents have

undoubtedly all originated by crystallization in the positions they now occupy and have not suffered at all from dynamic agencies. The coarser portions of the rock, and particularly those in immediate juxtaposition with the metallic iron, have a strongly marked cataclastic structure, the feldspars existing mainly as angular fragments. All structural features point to the injection of the metallic iron, or at least to its reduction to the metallic state, subsequently to the solidification of the stone, the same being accompanied by a shattering and more or less displacement of the minerals in the near vicinity. In the more siliceous portions the iron exists only in small round blebs and seems to have been wholly without effect on the structural features; but where existing in masses of some size the appearance is at once suggestive of subsequent injections and consequent disruption of particles.

The occurrence of the feldspars to the exclusion of the enstatites in the immediate vicinity of the metallic portions would be extremely suggestive could we consider both as products of solidification in place, from an iron-bearing magma, in the one case the elements combining to form an iron-rich silicate (enstatite) and in the other metallic iron and feldspar. The extremely fragmental condition of the feldspars, particularly when closely associated with the iron, suggests, however, that these were in a crystalline condition prior to the injection of the metallic portions, and hence that no such extreme phase of magmatic differentiation could have taken place.

It should be noted that the stone, as shown by sections cut from different fragments, is quite variable both in structure and in the relative proportions of its constituent minerals.

The meteorite is distributed, Ward possessing 4,259 grams.

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MOUNT JOY.

Mount Joy Township, Adams County, Pennsylvania.
Latitude 39° 47′ N., longitude 77° 13′ W.
Iron. Coarsest octahedrite (Ogg) of Brezina.
Found 1887; described 1892.
Weight, 383.5 kgs. (847 lbs.).

This meteorite was first described by Howell[1] as follows:

The Mount Joy meteorite, the third largest meteorite found in the United States, and the largest east of the Mississippi River, was found in November, 1887, on or about the 16th of the month, by Jacob Snyder, about a foot below the surface while digging to plant an apple tree near his house, 5 miles to the southeast of Gettysburg, in the township of Mount Joy, Adams County, Pennsylvania. It was supposed by the finder and his friends to indicate the near presence of an iron mine, and considerable prospecting was done to locate it. The meteorite was placed on some timbers in the open air, where it remained until the summer of 1891 before it was seen by anyone who surmised its true character.

Prof. F. W. Clarke induced Mr. Snyder to send it to the National Museum for inspection, but was finally unable to secure it, as Mr. Snyder was unwilling to part with it for a price which the museum felt justified in paying. I, therefore, purchased it from Mr. Snyder on August 15, 1891. The three largest dimensions of the meteorite are 11, 24, and 33.5 inches and it weighed on the museum scales 847 pounds. Professor Clarke had a few ounces taken off for examination; with this exception and the scaling of decomposed crust from the outside the mass still remains as it was found.

Professor Clarke has kindly furnished me with the following analysis, made by Mr. L. G. Eakins in the laboratory of the United States Geological Survey.

Professor Clarke did not succeed in developing the Widmanstätten figures satisfactorily, and the small amount of nickel shown by the analysis would indicate a poor etching iron; when larger surfaces are available we shall doubtless obtain better results.

Fe	Ni	Co	Cu	P	S	
93.80	4.81	0.51	0.005	0.19	0.01	=99.325

No idea can be formed of the length of time the meteorite had lain in the ground and very little of the amount of surface decomposition; it has undergone sufficient, however, to remove all the finer pittings, leaving a comparatively smooth surface.

Having been much interested in Mr. Davison's examination of the magnetic properties of the Welland meteorite, and thinking that this line of investigation in other meteorites might lead to interesting results, I requested Mr. Marcus Baker, of the United States Geological Survey, to make an examination of the meteorite, which he kindly consented to do.

The result of this examination is to show that the meteorite, as a whole, acts as a mass of soft iron, gaining polarity under the inductive action of the earth. The lower portion on the north side became a north-seeking pole, while the upper part became a south-seeking pole; a pretty distinct neutral line was shown, inclined to the horizon at an angle (20°–25°) which is approximately the complement of the local inclination of the dipping needle. This induced polarity shifted with each change in the position of the whole mass, and in general this shifting of the poles took place promptly though not always at once. Mr. Baker also states that his observations suggested the probable existence of an unequal distribution of permanent magnetism, but this matter requires further investigation.

Brezina [2] made the following observation in regard to the meteorite:

A lumpy grain of the size of a nut which fell out during the cutting shows the imprint of the neighboring grains. Upon the section surface are to be seen bent Neumann lines with somewhat bright yellow-colored porous crystals of troilite.

After acquisition of the principal part of the mass by the Vienna Museum the structure was studied by Berwerth [3] with the following results:

The analysis by Eakins led Linck to class Mount Joy as a hexahedrite, and when later Brezina, on a piece broken from the surface, observed Neumann lines the meteorite was classed as a breccialike hexahedrite. For the purposes of investigation and material for exchange the mass at the Vienna Museum was sawed in two parts in the direction of its principal section, and the smaller part cut into corresponding smaller plates parallel with this section. The faces obtained were so large and their character so remarkable that a complete investigation of the iron is in preparation; here the only endeavor will be to correct the error regarding its structure which has crept into literature. The preparation of the faces for exhibition showed without question that Mount Joy belongs to the octahedral irons, and by its very coarse structure should be placed among the last of the octahedral irons classed as having coarsest lamellæ. The general structure of Mount Joy is that of a coarse-grained mass, the coarse grains of which are intergrown and so elongated with a certain regularity in one direction that the grains have a relatively short rodlike shape. From this shape and the position of the grains arises an appearance of Widmanstätten figures that is plain to the eye on a large section. The fine crystalline structure of the single grains makes the figures more distinct, since the grains show a similar course of Neumann lines, luster, and sheen. Contrary to the usual structure of octahedral irons with more compact band systems, Mount Joy shows by reason of the more granular than lamellar formation a disconnected network of figures. A regular inclusion of fine rhabdite is common to the grains. As regards the appearance of the etched surface the grains show two characters. Along the section the course of the Neumann lines is shown plainly. In another part of the mass the Neumann lines show only very weakly. This disguised appearance of the lines comes from the fact that the mass of the grains has a composition of two fields, one of which is depressed and the other appears swollen on the etched surface. This gives a spongy or shagreened appearance. In certain sections this etching of the fields is oriented. The two fields show parallel striæ and resemble the perthitic structure seen in twin feldspars. Of other components which occur in the meteorite, troilite is present only in relatively small quantity in scattered nodules of medium size. Single nodules contain white and lustrous crystalline inclusions. The troilite is regularly surrounded by a coating of schreibersite. Schreibersite appears in larger skeletonlike crystals in the iron grains, also inclosing the troilite and interspersed between the grains. Where the spaces between the grains are open wide and are cleft a dark oxidation product of iron taking a good polish accompanies the schreibersite. These fillings are commonly regarded graphitic. Graphite seems, however, to be everywhere lacking. Where these oxidized interspersions are extensive there may also be seen an earthy yellow silicate. To the above may be added the statement that the manner of the octahedral structure of Mount Joy, showing its composition of great cubic crystalloids, requires a change in the present classification of iron meteorites. Probably a revision of the so-called breccialike hexahedrites will be required and its members put into the octahedrite division. Thus Sao Julíao belongs, doubtless, to the octahedral irons. Further, it is indicated that all iron meteorites possess an octahedral structure and that the meteorites of hexahedral structure which have fallen to our earth are simply fragments of octahedral irons of very coarse structure.

The mass is somewhat distributed but is chiefly in the possession of the Vienna Museum (171,860 grams).

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Mount Ouray. See Ute Pass.

MOUNT VERNON.

Christian County, Kentucky.
Latitude 36° 55′ N., longitude 87° 25′ W.
Ironstone. Brecciated pallasite (Pb), of Brezina.
Found 1868; described 1903.
Weight, 159.2 kgs. (351 lbs.)

This meteorite was first described by Merrill,[1] as follows:

The United States National Museum has recently come into possession of a heretofore undescribed meteorite from the farm of Capt. S. T. Fruit, in Mount Vernon Township, about 7 miles northeast of Hopkinsville, in Christian

County, Kentucky. The meteorite, which is a pallasite, has been known for some 35 years by the occupant of the premises, where it served as a convenient stone on which to clean his boots after crossing the muddy fields. Although recognized as of a peculiar type of stone, no suspicion of its meteoric nature was entertained, and it was only when the zinc and lead mining excitement of 1902 caused a sample of it to be sent to Mr. E. O. Ulrich, of the United States Geological Survey, with a request for information, that its true nature became known. It is through the influence of Mr. Ulrich that the specimen was obtained for the National Museum.

Prolonged exposure has, naturally, brought about a great amount of oxidation to the exterior portion of the material. More than that, the rough usage to which the exposed portion was subjected, and the breaking away of small masses by the curious and the prospector, has so obscured the original form that little of value on this subject can be said. The mass, as it came to the museum, is in the form of a rude prism some 55 cm. in height, with sides measuring 33 cm. and 36 cm., respectively. Although badly oxidized, two of the sides show rough pittings.

As stated above, the stone is a pallasite. It differs, however, from the usual pallasites in that, while those may properly be described as spongy masses of iron containing silicate minerals, this is really a mass of silicate with a cementing of iron, the proportion of iron, so far as can be determined from examination of the exterior of the mass, or of the small pieces which have been broken away, being much less than in the case of the pallasite of Kiowa County, Kansas. From the Admire pallasite, described by the present writer in the Proceedings of the United States National Museum for 1902, it differs in that the silicate (in this case olivine) occurs in large rounded blebs rather than in sharply angular fragments. In this respect also it differs from the Eagle Station, Kentucky, pallasite.

The mineral composition of this meteorite, so far as determined, has already been suggested. The main mass of the material is of olivine in rounded blebs and in sizes varying from 5 to 25 mm. in diameter. These are quite closely compacted, with the usual nickel-iron alloy in the interstices, and serving as a binding constituent, and in smaller proportions the customary phosphide and sulphide.

Although the meteorite has not yet been fully investigated, it is of interest in bearing out certain observations by the writer in the case of the Admire, Kansas, meteorite, viz, the olivines are often shattered, with thin plates—mere films or veinlets—of the phosphide extending up through them, as described in the paper already quoted.

A slab will be sawn from the entire length of one side of the mass for the purpose of showing its internal structure and securing material for study, the main mass being kept intact, after the usual custom of the museum. It is expected that later more complete analyses will be made and a more detailed description given.

The weight of the mass as received was 351 pounds (159.21 kgs.). It will be known as the Mount Vernon meteorite.

A later detailed account was given by Tassin,[2] as follows:

The meteorite here described was found on the farm of Capt. S. T. Fruit, in Mount Vernon Township, about 7 miles northeast of Hopkinsville, Christian County, Kentucky. Although known for some 35 years, its meteoric origin was not suspected until 1902, and the first published account and preliminary description was given by Dr. George P. Merrill, in the American Geologist in 1903.

A cut surface shows the mass to be a pallasite of the Krasnojarsk type (Pk), consisting essentially of nickel iron occurring in cohering spongiform or reticulated masses containing olivine and varying amounts of troilite, schreibersite, carbon, chromite, and lawrencite.

The nickel-iron constituent comprises about one-third of the mass of the entire surface as cut, and serves as a matrix in which are contained rounded blebs of olivine varying in size from 1 to 30 mm. in diameter. Dislodging the olivine blebs will in general disclose a very thin, black, specular film more or less completely lining the entire cavity, and which is rich in carbon and usually contains some chlorine as chloride, together with more or less sulphur as sulphide. Next to this is frequently found a more or less continuous layer of schreibersite or troilite, or both. These in turn are followed by the nickel-iron constituent made up of kamacite, tænite, etc.

The olivine blebs are quite commonly penetrated by cracks in all directions. These cracks may or may not be filled with other substances. In the former case they are charged either with metallic iron, the black, specular chlorine-containing material above referred to as commonly surrounding the olivine, and which often contains chromite, with limonite (probably resulting from the oxidation of the specular substance), and which also contains chromite, or, and this but rarely, with schreibersite or troilite.

The mass contains, approximately, the following percentage composition, calculated from the results of several analyses:

Olivine	63.15
Nickel iron	33.12
Schreibersite	1.95
Troilite	.69
Chromite	1.00
Carbon	.09
Chlorine	trace
	100.00

This agrees fairly well with the composition of the mass as determined by the measurement of the areas of its constituents, the mean of some 300 measurements giving the following values:

Olivine	61.75
Nickel iron	36.52
Schreibersite	1.35
Troilite	.38

Some 400 grams in all of the mass were taken for separation and analysis, and in the several portions of this the following were separated:

The nickel-iron alloy.—This constituent approximates one-third of the whole. It occurs in cohering spongiform masses of irregular shapes, some of them measuring a centimeter along their greatest diameters, while others are merely hairlike filaments.

Etching shows that the mass of the iron constituent is made up of a darker colored alloy in which is seen fine lines of a tin-white color, which are in part oriented and in part penetrate the mass in zigzag shapes. Bounding this eutectic is seen a band of bright, white iron, which varies in width from a line to a millimeter.

Examined under the glass the mass of the iron constituent appears to be made up of minute octahedrons arranged in fine lamellæ, and considered as a unit may be defined as a granular octahedrite containing more or less numerous troilite and schreibersite areas.

Two portions of this constituent, each weighing 10 grams, were taken for analysis, and after treating with dilute acid for the separation of schreibersite, tænite, etc., were examined as follows: In one the silicon, iron, aluminum, copper, cobalt, nickel, and sulphur were determined; in the other the carbon and phosphorus, with the following results:

Iron	82.520
Nickel	14.044
Cobalt	0.949
Copper	0.104
Sulphur	0.288
Silica	0.808
Aluminum	0.410
Carbon	0.465
Phosphorus	0.390
Chlorine	trace
	99.978

Tænite occurs in very thin, brittle, tin-white lamellæ, with a specific gravity of 7 at 20.1° C., and having the following composition:

Iron	63.99
Nickel	35.98
Cobalt	0.10
Copper	trace
Phosphorus	0.04
	100.11

The material was strongly magnetic, but did not possess polarity.

Schreibersite occurs fairly abundantly, approximating as it does 1.35 per cent of the mass by measurement and 1.95 per cent by analysis. It is found bounding the olivine areas and occasionally penetrating or contained in them. The more common occurrence is, however, as blebs, veins, or filaments in the nickel-iron constituent. The mineral has a brilliant tin-white color, is strongly magnetic, possessing polarity, and in one instance was undoubtedly crystallized, but, unfortunately, the specimen was so brittle that it fell to pieces on attempting to measure it.

An analysis gave the following:

Iron	64.990
Nickel	18.905
Cobalt	0.105
Phosphorus	15.700
Copper	trace
	99.700

Troilite occurs commonly associated with the black specular material lining the cavities containing the olivine in the nickel-iron constituent. It varies in its dimensions from a coating a line in thickness to masses 2 or more millimeters thick by 10 mm. in length. Grains and flakes of troilite are occasionally contained in masses of the nickel-iron alloy and may then be associated with schreibersite areas. Further, it may occur as isolated grains or flakes and filling cracks in the olivine areas.

The material analyzed was obtained by treating the metallic portion with mercury bichloride, and after its solution separating the troilite and schreibersite from carbon, silicates, etc., with the magnet and from each other by lixiviation. The material thus obtained had a specific gravity of 4.759 at 18° C. and the following composition:

Iron	62.99
Nickel, Cobalt	.79
Phosphorus	trace
Sulphur	36.35
	100.13

The specular material lining the olivine cavities is essentially a graphitic iron containing sulphur and chlorine. The material analyzed was far from being homogeneous, as it was separated mechanically with the aid of a glass. The composition was as follows:

Iron	84.900
Nickel, Cobalt	5.039
Silica	2.990
Carbon	2.810
Sulphur	1.750
Phosphorus	1.470
Chlorine	0.100
Alumina	0.940
	99.999

Chromite occurs quite abundantly, varying in size from microscopic grains to a crystal 1 mm. in diameter. The crystals are more or less perfect octahedrons, rarely modified by other forms, and then only by the dodecahedron (110), as noted in one instance. They are brilliant black in color with a metallic luster; nonmagnetic; have a specific gravity of 4.49 at 18° C., with the following composition:

Chromic oxide	64.91
Alumina	9.85
Magnesia	4.96
Ferrous oxide	17.97
Silica	1.38
	99.07

Olivine occurs in more or less rounded masses which, when carefully extracted, show well-marked facets. These facets are probably not to be referred to any crystal forms, since no zonal relations could be established after repeated measurements. The mineral is commonly brownish in color and only occasionally honey yellow. The blebs are more or less cracked and the cracks filled with foreign material, as graphitic iron, limonite, chromite, etc. Some of the clearest grains, which under the glass were quite free from impurities, were selected for analysis, with the following results:

Silica	35.70
Magnesia	42.02
Ferrous oxide	20.79
Ferric oxide	0.18
Alumina	0.42
Manganese	0.14
Nickel oxide	0.21
Phosphorus	trace
	99.46

The meteorite is somewhat distributed, but is chiefly in the possession of the U. S. National Museum.

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Muchachos. See Tucson.

MURFREESBORO.

Rutherford County, Tennessee.
Latitude 35° 50′ N., longitude 86° 25′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found? described 1848.
Weight, 8.5 kgs. (19 lbs.).

The first account of this meteorite was given by Troost [1] as follows:

To these 10 aerolites (of Tennessee) I add now an eleventh meteoric mass of iron, discovered a few months since, a few miles from Murfreesboro, in Rutherford County, Tennessee.

The history of its discovery is similar to that of the generality of these meteorites. Nothing is known of its fall; it was accidentally discovered by gold and silver hunters, and being at first considered as containing these precious metals it was kept a profound secret till it was found out to be iron, when no difficulty was made to part with it for a pecuniary consideration. When this discovery is made, these aerolites generally get into the hands of those that know how to appreciate them; and such is also the history of the Rutherford iron.

The mass as it first came into my possession (only a very small part being chiseled off) weighed about 19 pounds; it had an irregular oval shape and was surrounded with a crust of about 2 mm. in thickness, resembling the brown hydroxide of iron, the pure metal being here and there visible. This metal has the common luster of iron; its fracture is very crystalline and it is very malleable though harder than any of the Tennessee meteoric irons, having taken longer time to be sawed.

The specimen of it in my collection weighs 10 pounds 14 ounces; it has a polished surface of an irregular elliptical form 10 by 6 inches diameter, exhibiting fine Widmannstätten figures of a rhomboidal and triangular form.

It seems pretty free from intermixture with other matter, only one circular mass of 0.3 inch in diameter is brought to light on the sawed surface which, judging from its structure and the action of acid upon it, I am inclined to consider as sulphuret of iron (magnetic pyrites); on the other surface are two small cavities, one of about 0.2 and the other 0.1 of an inch in diameter; with these exceptions the metal is homogeneous and compact.

From an imperfect analysis to which I have subjected it, it appears to contain less nickel than any of the Tennessee meteoric masses, being composed of 96 iron, 2.40 nickel, and 1.60 matter not examined.

Shepard [2] remarked the presence of two small cavities in the iron, one 0.2 and the other 0.1 of an inch in diameter.

Brezina [4] in 1885 made the iron the type of a group among the medium octahedrites. He gives the width of the lamellæ as 0.75 mm. and remarks that they are less sharply bounded than those of Cross Timbers and Werchne Udinsk.

Meunier [5] makes the following observations:

This iron gives the characteristic figures of the caillite type. The kamacite is characterized by the distinctness of the Neumann lines, which give the etched surfaces a peculiar watered appearance.

In 1895 Brezina [6] remarked further:

It is evident from two different positions of the same portion of this iron with reference to the light that the oriented luster of the laminæ run in at least three directions since in the case of these two positions there is not shown a complete reversal of the illumination.

The meteorite is distributed, Harvard possessing 2,428 grams and the British Museum 2,794 grams.

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MURPHY.

Cherokee County, North Carolina.
Latitude 30° 10′ N., longitude 84° W.
Iron. Hexahedrite (H) of Brezina.
Found 1899.
Weight, 7.7 kgs. (17 lbs.).

This meteorite was first described by H. L. Ward [1] as follows:

In May of the present year we received word from Mr. W. B. Lenoir that he had what he supposed to be a meteorite that he desired to sell. Upon request he forwarded it to us; and a superficial glance at the well-pitted surface was sufficient to determine that it was a siderite.

Under date of May 25, Mr. Lenoir writes: "It was ploughed up or washed out in a field in Cherokee County, North Carolina, 5 miles from Murphy. From the location [where] found I think it must have been washed out by some of the immense rains which fell in that section last winter. . . . The small piece inclosed with the larger one was broken off when I purchased it. . . . The stone [iron] I understand was found about six weeks ago." Later he writes: "In answer to yours of June 10, asking how the meteorite was broken, will say that I did not break the meteorite. The man who first showed me the piece said that they attempted to cut it with a cold chisel and did not succeed. By some means (I think he said) they cut around it and then either with a blow or by prying broke it off. . . . He said he had a 'hell of a time' breaking it."

As was to be expected, this meteorite adds another to the great majority of siderites the date of whose fall is unknown.

A figure shows the iron with the broken piece set in place so as to give the original form. Its height is 23.5 cm. A rectangle drawn about the base upon which it stands measures 13.4 by 11.5 cm. The weight of the iron was 7,753 grams (17 pounds 1.5 ounces), of which the broken end weighed 808 grams. Another photograph of the entire iron was taken to show the remarkably sharp angle formed by the left-hand edge and the side opposite to that shown in the figure above mentioned; but a defect in the plate rendered this photograph unusable. Another figure, showing end views of both pieces from the broken surface, gives something of this angularity which was rather more marked lower down. In some of the larger sections cut across the iron this angle is rather more acute than a right angle, as this side is somewhat concave, and the edge is very sharp. These two surfaces are less deeply pitted than the one shown in the figure; and convey the impression that the meteorite in hand is but a fragment of a larger one that broke not far above the earth. Had it traveled far since dividing we would expect the angles to be rounded. An examination of the crust fails to give any evidence for or against this theory. Flow lines, if they ever existed, have been removed by weathering and the oxidized crust appears equally thin on all sides. The fact that the edges of the mass are approximately parallel to the lines of crystallization is only in accordance with what has been shown to be common to siderites in general.

The square fracture is an interesting feature that I believe to be quite unusual in iron meteorites. Its surface is nearly a parallelogram 4.8 by 3.3 cm. with one of the shorter sides surmounted by a triangle 3.5 cm. in height, giving a surface of approximately 21.5 sq. cm. One side shows that it has been cut by a cold chisel to a depth of about 2 mm. The rest of the face is a clean straight break with a hackly surface.

The etched surface presents two main series of lines inclosing rhombs having the angles 161.2 and 18.8; other lines crossing these produce all the figures compatible with the twinning about a cube, with the exception of a single line which probably exists but which I have been unable to find.

Under the microscope each higher power up to about 100 diameters reveals lines not seen with lower powers. That the series of lines giving the angles above mentioned are the primary ones, is indicated by the fact that the lines of fracture on the broken face have followed these. On a section cut at right angles to these the lines apparent to the eye give decidedly larger figures, but under the microscope this distinction disappears.

Troilites appear in all the sections, but are in most cases of very small size. The largest one that appears measures 9 by 13 cm. in diameter. It is interesting to note that the Neumann lines are materially flexed immediately about some of the troilites, indicating that they existed in a plastic condition during the growth of the troilites.

Daubréelite in unusually large masses occurs in two of the slices, both as veins crossing the troilites and as solid masses at the sides. The largest mass measures on its two nearly rectangular faces 5.5 and 5 mm., the other sides being formed by a segment of the nearly circular border of the troilite within which it has formed.

An analysis of the iron has not yet been made.

Unfortunately the more euphonious title "Cherokee County" has already been applied to the Losttown, Cherokee County, Georgia, siderite and we are forced to adopt the less pleasing one of the town near which it was found, *Murphy*, as the name for this meteorite.

Cohen [2] gave an analysis of the meteorite and later [3] an account of its structure, as follows:

Murphy etches readily, and is distinguished by unusually long etching lines which cross one another in various directions; still it is not wanting in short ones which are usually sharply defined from the former on both sides of them. Etching pits are, with the exception of the immediate vicinity of the larger rhabdites, present everywhere, but in varying numbers. Sometimes they lie closely compacted together, and thereby produce irregular patches which in certain positions of the etched surface are quite strongly marked by a dull luster. The remaining portions have a bright luster, and here the pittings are very scarce, but uniformly distributed. Minor constituents are very sparingly represented. Especially noteworthy is the absence of the customary rhabdite needles, so characteristic of hexahedrites. Specific gravity, 7.7642.

Analysis by Fahrenhorst:

Fe	Ni	Co	Cu	Cr	S	P	Cl	C
93.93	5.52	0.61	0.02	....	....	0.34	0.06	0.04

Composition:

Nickel iron	97.69
Schreibersite	2.20
Lawrenceite	0.11
	100.00

The meteorite is distributed, the British Museum possessing 1,159 grams and Ward 567 grams.

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Muskingum County. See New Concord.

NANJEMOY.

Charles County, Maryland.
Latitude 38° 28′ N., longitude 77° 16′ W.
Stone. Spherical chondrite (Cc), of Brezina; Luceite (type 37, subtype 2), of Meunier.
Fell noon, February 10, 1825; described 1825.
Weight, 7.444 grams (16½ lbs.).

The first account of the fall of this meteorite was given by Carver,[1] as follows:

I take the liberty of forwarding you a notice of a meteoric stone which fell in this town on the morning of Thursday, February 10, 1825. The sky was rather hazy, and the wind southwest. At about noon the people of the town and of the adjacent country were alarmed by an explosion of some body in the air, which was succeeded by a loud whizzing noise, like that of air rushing through a small aperture, passing rapidly in the course from northwest to southeast, nearly parallel with the river Potomac. Shortly after, a spot of ground on the plantation of Capt. Wm. D. Harrison, a surveyor of this port, was found to have been recently broken, and on examination a rough stone of an oblong shape, weighing 16 pounds 7 ounces, was found about 18 inches under the surface. The stone when taken from the ground, about half an hour after it was supposed to have fallen, was sensibly warm, and had a strong sulphurous smell. It has a hard, vitreous surface, and when broken appears composed of an earthy or siliceous matrix of a light slate color, containing numerous globules of various sizes, very hard and of a brown color, together with small portions of brownish-yellow pyrites, which became dark colored on being reduced to powder. I have procured for you a fragment of the stone, weighing 4 pounds 10 ounces, which was all I could obtain. Various notions were entertained by the people in the neighborhood on finding the stone. Some supposed it propelled from a quarry 8 or 10 miles distant on the opposite side of the river, while others thought it thrown by a mortar from a packet lying at anchor in the river, and even purposed manning boats to take vengence on the captain and crew of the vessel.

I have conversed with many persons living over an extent of perhaps 50 miles square; some heard the explosion, while others heard only the subsequent whizzing noise in the air. All agree in stating that the noise appeared directly over their heads. One gentleman, living about 25 miles from the place where the stone fell, says that it caused his whole plantation to shake, which many supposed to be the effect of an earthquake. I can not learn that any fireball or any light was seen in the heavens; all are confident that there was but one report, and no peculiar smell in the air was noticed.

I herewith transmit the statement of Captain Harrison, the gentleman on whose plantation the stone fell:

"On February 10, 1825, between the hours of 12 and 1 o'clock, as nearly as recollected, I heard an explosion, as I supposed, of a cannon, but somewhat sharper. I immediately advanced with a quick step about 20 paces, when my attention was arrested by a buzzing noise, resembling that of a humming bee, which increased to a much louder sound, something like a spinning-wheel, or a chimney on fire, and seemed directly over my head, and in a short time I heard something fall. The time which elapsed from my first hearing the explosion to the falling might have been 15 seconds. I then went with some of my servants to find where it had fallen, but did not at first succeed (though, as I afterwards found I had got as near as 30 yards to the spot); however, after a short interval the place was found by my cook, who had (in the presence of a respectable white woman) dug down to it before I got there, and a stone was discovered from 22 to 24 inches under the surface, and which, after being washed, weighed 16 pounds, and which was no doubt the one which I had heard fall, as the mud was thrown in different directions from 13 to 16 steps. The day was perfectly clear, a little snow was then on the earth in some places which had fallen the night previous. The stone when taken up had a strong sulphurous smell, and there were black streaks in the clay which appeared marked by the descent of the stone. I have conversed with gentlemen in different directions, some of them from 18 to 20 miles distant, who heard the noise, not the explosion. They inform me that it appeared directly over their heads. There was no fireball seen by me or others that I have heard. There was but one report, and but one stone fell to my knowledge, and there was no peculiar smell in the air. It fell on my plantation, within 250 yards of my house, and within 100 of the habitation of my negroes.

"I have given this statement to Doctor Carver, at his request, and which is as full as I could give at this distant day, from having thought but little of it since. Given this 28th day of April, 1825."

An analysis of the meteorite was made by Chilton,[2] as follows:

The piece of Maryland aerolite subjected to examination weighed 228.30 grams in air and lost 62.25 grams by immersion in water at 60°. Its specific gravity is therefore 3.66. The external crust was taken off and the remainder

powdered, not very finely, and separated into two parts by the magnet; 40 grams were obedient to the magnet; 25 of which were taken for examination. The same quantity was taken of the unmagnetical portion.

The unmagnetical portion yielded:

SiO_2	Al_2O_3	MgO	CaO	FeO	NiO	S	
14.90	0.05	2.60	0.45	6.15	0.80	1.27	=26.22

The magnetic portion yielded:

FeO	NiO	SiO_2	S	
24.00	1.25	3.46	trace	=28.71

A further account of the meteorite was given by Silliman [2] in the same article, as follows:

An excellent specimen, for which we are indebted to Dr. Samuel D. Carver, weighs 4 pounds 5 ounces. Its dimensions are 7 by 3 by 4 inches; its form is that of an irregular ovoidal protuberance nearly flat where it was detached from the larger mass and bounded by irregular curves in the other parts of the surface. In all parts, except where it has been fractured, it is covered by the usual black vitreous coating which, in this case especially when it is viewed by a magnifier, has more luster than is common. This coating is severed by innumerable cracks running in every direction and communicating with each other so as to divide the surface into polygons resembling honeycomb or madrepore, and no undivided portion of the surface exceeds half an inch in diameter.

This circumstance is much less apparent upon the aerolites of Weston (1807), L'Aigle (1803), and Stannern in Moravia (1808); it appears to have arisen from the rapid cooling of the external vitreous crust after intense ignition. It is impossible to doubt that this crust is a result of great and sudden heat. In the Maryland aerolite it is not quite so thick as the back of a common penknife and, as in that of Weston and Stannern, it is separated by a well-defined line from the mass of the stone beneath. The mass of the stone is, on the fractured surface, of a light ash-gray color, or perhaps more properly of a grayish-white; it is very uniform in its appearance and not marked by that strong contrast of dark and light gray spots which is so conspicuous in the Weston meteorolite. The fractured surface of the Maryland stone is uneven and granular, harsh and dry to the touch, and it scratches window glass decidedly, but not with great energy. To the naked eye it presents very small glistening metallic points and a few minute globular or ovoidal bodies scattered here and there through the mass of the stone. With a magnifier all these appearances are of course much increased. The adhesion of the small parts of the stone is so feeble that it falls to pieces with a slight blow and exhibits an appearance almost like grains of sand. The metallic parts are conspicuous but they are much less numerous than the earthy portions which, when separated, are nearly white and have a pretty high vitreous luster, considerably resembling porcelain. They appear as if they had undergone an incipient vitrification and as if they had been feebly agglutinated by a very intense heat. I can not say that I observed in them, as M. Fleurian de Bellevue did in the aerolite of Jonzac (Journ. de Phys., tome 92, p. 136), appearances of crystallization, although it is possible there may have been an incipient process of that kind, especially as the small parts are translucent. The Maryland stone is highly magnetic; pieces as large as peas are readily lifted by the magnet and that instrument takes up a large proportion of the smaller fragments. The iron is metallic and perfectly malleable; although none of the pieces are larger than a pinhead, still they are readily extended by the hammer. The iron in the crust is glazed over so that the eye does not perceive its metallic character, but the file instantly brightens the innumerable points which then break through the varnish of the crust and give it a brilliant metallic luster at all the points where the file has uncovered the iron. The same is the fact with the Weston stone and with that of L'Aigle, but not with that of Stannern in Moravia; specimens of all of which and of the meteoric iron of Pallas, of Louisiana, and of Auvergne are now before me. The aerolites of Jonzac and of Stannern, as stated by M. Bellevue, are the only ones hitherto discovered that do not contain native iron and do not affect the magnet; still their analysis presents a good deal of iron which is probably in the condition of oxide.

The iron in the metallic state is very conspicuous in the Weston stone, sometimes in pieces of 2 inches in length, and both in this stone and in that of Maryland it is often brilliant like the fracture of the meteoric iron of Pallas and of Louisiana.

In the analysis of the Weston stone published in 1808 I did not discover chrome although it was afterwards announced by Mr. Warden. I have desired Mr. Chilton to reanalyze the Weston stone and he has nearly completed the labor, the result of which may be given hereafter, but he writes that he has not been able to discover any chrome. I am not quite sure that I discover pyrites in the Maryland aerolite, although it is mentioned by Dr. Carver in his letter in the preceding volume.

Partsch [3] described the specimen in the Vienna collection as—

Groundmass varying between light and dark gray, partly spotted with rust flecks; in part showing lighter but generally darker spherical inclusions firmly intergrown. There is a considerable sprinkling of iron and pyrrhotite. Crust rough and dull, broken by narrow clefts.

Shepard [4] gave the following notes:

Its crust resembles that of the Iowa stone (Marion) without, however, possessing its uniformity of thickness or its deep black color. The proportion and mode of dissemination of the nickel-iron and of the pyrites is very similar in both; but the color of the earthy mineral in the Maryland is several shades darker and more inclined to blue. The iron-rust points are less frequent than in the Iowa meteorite. Like the latter it is principally composed of howardites; although rounded grains of olivinoid to the amount perhaps of 15 per cent are distinguishable with the aid of the microscope.

Meunier [5] gave Chilton's analysis in percentage form as follows:

Nonmagnetic portion.

SiO_2	MgO	CaO	Fe_2O_3	NiO	Al_2O_3	S	
59.6	10.4	7.8	24.6	3.2	0.2	5.08	=104.88

Magnetic portion.

SiO_2, MgO, and CaO	Fe	Ni	
13.84	96.00	5.00	=114.84

He also gives the specific gravity, according to Rumler, as 3.6062.

Brezina [6] in 1885 classed the meteorite as a gray chondrite. In 1895 [7] he removed it from this class and placed it with the spherical chondrites. He states:

The Vienna specimen shows an inclination toward Cc; the two pieces in the Tübingen collection, of 100 and 82 grams weight both with crust, show a decided spherical chondritic structure with slaglike crust up to 2.5 mm. in thickness.

The meteorite is distributed, Yale possessing 897 grams, Vienna 351 grams.

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Nash County. See Castalia.

Nashville. See Drake Creek.

Nebraska. See Fort Pierre.

NELSON COUNTY.

Nelson County, Kentucky.
Latitude 37° 50′ N., longitude 85° 25′ W.
Iron. Coarsest octahedrite (Ogg), of Brezina; Nelsonite (type 5), of Meunier.
Found 1856; described 1860.
Weight, 73 kgs. (161 lbs.)

This meteorite was first described by Smith,[1] as follows:

This meteorite came into my possession in the month of July, 1860, being obtained from a plowed field, where it may have lain for a considerable length of time. It is a flattened mass of tough metal, a little scaly at one corner, being 17 inches long, 15 inches broad, and 7 inches in the thickest part, shelving off like the back of a turtle; and weighs 161 pounds. It is free from any large proportion of thick rust, consequently showing no indication of chlorine. Upon analysis the following constituents were found in one hundred parts:

Fe	Ni	Co	P	Cu	
93.10	6.11	0.41	0.05	trace	=99.67

Shepard [2] listed the meteorite as found in 1856.

Meunier [5] made the meteorite the type of Nelsonite, which he describes as—

A metallic rock, very crystalline, taking a good polish. Formed of an alloy of iron and nickel to which we give the name kamacite, and having the formula Fe_{14} Ni. One distinguishes cylindrical nodules of troilite and more or less irregular masses of schreibersite. Acids give very remarkable Widmanstätten figures.

Brezina,[6] in 1885, gave the following description:

Tschermak classified this iron as a brecciated hexahedrite. This can not be, as it shows distinctly areas composed of tænite; it can therefore be only an octahedral breccia. I consider it an octahedral iron which belongs to the Seeläsgen group and only appears brecciated because of the interweaving and variable breadth of the bands.

Huntington [7] states that—

An etched surface on a mass of the Nelson County iron, weighing 6,800 grams and measuring 13 inches in its longest dimension, presents perfectly distinct figures near the center of the section, which grow indistinct near the edges and entirely fade out at one end.

Cohen [8] gave another analysis of the meteorite as follows:

Some small pieces of Nelson County were obtained from the Vienna Museum for investigation. A new analysis seemed desirable since the older analysis by Smith seemed to give too low a content of Ni+Co.

The analysis by Manteuffel on 0.9259 grams gave the following:

Fe	Ni	Co	Cu	P	
91.86	7.11	0.65	0.01	0.15	=99.77

For the copper determination, 5.369 grams were employed. Test for antimony and arsenic with hydrogen sulphide gave no results, as did also a second test for arsenic made by dissolving 4 grams in nitric acid, and after addition of sulphuric acid testing directly with Marsh's apparatus. Calculating schreibersite and removing it from the analysis, then calculating to 100, one obtains:

Fe	Ni	Co	Cu	
92.42	6.91	0.66	0.01	=100 (Manteuffel)
93.53	6.06	0.41	trace	=100 (Smith)

This composition indicates an octahedrite poor in tænite, while Smith's analysis corresponds to an iron free from tænite.

Meunier,[9] in 1893, made the following further observations:

This interesting meteoric iron offers some very special characters, the careful study of which serves to notably lessen the number of meteorites which at first seem to resemble it. It is more important here than in certain other cases to etch some specimens intact and to develop the figures by a process comparable to that which gives them on the other types. When the action of the acid is complete, one sees the great bands of kamacite appear, mixed with other substances, among which are specially notable the filaments of tænite and some grains of schreibersite of a silver-white color. An analysis by L. Smith (Mineralogy and Chemistry, p. 317, 1873) indicates for this iron figures very closely approximating those for pure kamacite:

Fe	Ni	Co	P	Cu	
91.12	7.82	0.43	0.08	trace	=99.45

Brezina,[10] in 1895, classed the meteorite as coarsest octahedrite, and stated the structure was unit octahedral.

The almost complete lack of tænite causes the breadth of the lamellæ, even in one and the same lamella, to vary remarkably and the lamellæ often have a wavy outline and apparently penetrate one another. Also, weathering shows the octahedral nature of the iron. The octahedral lamellæ separate under such a loosening of the structure, and the mass falls to pieces into larger or smaller fragments which usually are sharp pointed at the edges. The kamacite is fine and compact with the hatchings mostly bent. Troilite is very scarce, in small globules up to the size of mustard seeds.

Cohen [11] found that the meteorite took no permanent magnetism.

The meteorite is distributed, but the main mass (24,409 grams) is at Vienna.

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NESS COUNTY.

Kansas.
Latitude 38° 20′ N., longitude 99° 37′ W.
Stone. Brecciated intermediate chondrite (Cib) of Brezina.
Found 1897; described 1899.
Weight, many stones.

This meteorite was first described by H. L. Ward[1] as follows:

In October, 1899, Sam G. Sheaffer, Esq., attorney at law, of Ness City, Kansas, called our attention to a meteorite that he had in his possession and which, after some correspondence, he sent to Ward's Natural Science Establishment for the purpose of disposing of it.

Mr. Sheaffer writes that "it was found about a year ago in the southwest of this, Ness County, Kansas. Was picked up on the side of a draw, i. e., a dry creek, where the surface had been eroded."

In form it is a triangular pyramid with the base set obliquely to its perpendicular.

A mass of some weight had long ago separated from the lower left-hand corner, as seen in the figure, but whether before, upon, or after reaching the earth it is now impossible to determine from the fractured part. Several slight depressions appear on the surface which are rather too sharply indicated in the accompanying figure. The edges of the nearly plane faces meet in rounded angles.

The meteorite is 92 mm. in length, 64 mm. across its widest face, left to right of figure, and 49 mm. in thickness measured perpendicularly to the widest and also largest face. The termination had been chipped away for the purpose of ascertaining its meteoric character before it was sent to us. The weight of the mass is 417 grams.

This is not a prepossessing meteorite. It entirely lacks the black crust characteristic of aerolites; and so strongly suggested a weathered marcasite concretion that we were at first skeptical as to its meteoric origin. However, tests for iron and for nickel were both affirmative and a polished chip showed the former well distributed as minute specks through the mass. A complete analysis has not yet been made.

To our knowledge but one other meteorite has been described from Ness County, Kansas. That is the Kansada aerolite designated by the name of the town near which it was found. The locality whence came the specimen under consideration, sec. 2, T. 20 S., R. 21 W., is not marked by a town and I therefore propose to designate this meteorite as the Ness County.

Subsequent to Ward's account a number of other stones were found and of these further information was given by Farrington[2] as follows:

Of this fall the Field Museum possesses one small complete individual having a weight of 85 grams. This aerolite in general form is wedge-shaped with angles but little rounded. Except for one fractured surface it is covered with a black crust or one which was undoubtedly originally all black, but through weathering has taken on in places a rusty brown appearance. The crusted surface is smooth but uneven, the irregularities suggesting pitting, although the depressions are not deep enough to produce pits of definite form. On making a section through the stone and polishing the surface thus exposed the crust appears as a distinct black border having a thickness of about 0.25 mm., in contrast to the dark brown color of the interior of the stone. In texture the crust does not differ noticeably from the interior, the porosity of many meteorite crusts not being in evidence. The dark brown color of the interior of the stone is doubtless largely a discoloration due to weathering. So completely has this discoloration penetrated the stone that it is impossible to find a place where the probable original color remains. The discoloration also makes it impossible to make out much regarding the structure of the stone megascopically, chondri not being visible on a polished surface. Metallic grains are numerous over the polished surface. They are for the most part of small size, the largest that I have noticed not being over 1 mm. in diameter. They consist both of nickel iron and troilite, the grains of the latter being distinguished by their yellow color and by not taking on a deposit of copper when immersed in copper sulphate. These troilite grains are quite as numerous as the grains of nickel iron but never as large.

In texture the stone is compact but it is only fairly coherent, breaking rather easily with a blow of a hammer. The specific gravity of the whole aerolite of 74 grams, taken with the balance at 21° C., was found to be 3.504. This value is of course slightly affected by the crust of the stone, but as a fragment without crust weighing 3.4 grams gave the same result the error from this cause must be very small.

Under the microscope the rock is seen to be a crystalline aggregate made up chiefly of grains of chrysolite, bronzite, nickel iron, and troilite. Here and there are traces of a structure which may indicate chondri or fragments of them, but such occurrences are rare. The chondruslike structures lack definite outline and if of chondritic origin can only be considered fragments. One such fragment seen consists of alternate narrow lamellæ, of about equal width, of chrysolite and glass. In another the lamellæ of chrysolite are broader and the mass has a border of chrysolite. Another suggests a portion of a polysomatic chrysolite chondrus. The grain of the stone as a whole is coarse, many of the chrysolite individuals reaching diameters of 0.2 to 0.4 mm. These incline to a porphyritic development, although the whole rock is crystalline. The chrysolite individuals are in general considerably seamed and fissured and stained brown from the penetration of iron rust. Where not stained they are colorless except for scattered minute black inclusions which occur in considerable quantity. They occasionally have prismatic outlines but are more often rounded or fragmental. Elongated fibers alternating with glassy or half-glassy lamellæ also occur as previously noted.

A few well-marked aggregations of black, probably carbonaceous matter, occur mixed in a glassy or half-glassy groundmass, the whole having an approximately circular outline, and reaching in one case 0.5 mm. in diameter. Here again a chondritic form is suggested but can not be positively discerned. The carbonaceous matter is made up of smaller black particles not different from those included in the large chrysolite individuals.

The bronzite usually occurs in the typical fibrous development. It is colorless to yellow, the latter perhaps being due to iron stain.

Quite frequently large grains of an isotropic mineral appear which I can not yet refer to any species with which I am familiar. The grains are marked by large size and freedom from inclusions and cracks such as characterize the other silicates of the meteorite. One grain seen has 0.7 sq. mm. of surface, another 0.5 sq. mm., while the remainder are smaller. The outline of the grains is irregular and separated from the remaining constituents. Good cleavage is shown in some of the grains and is apparently cubic, although in one individual the planes meet at angles of 50°. The mineral is colorless inclining to a pink tinge. Relief and index of refraction about like that of chrysolite. I hope to give the mineral further investigation when a larger quantity is available.

The metallic grains (nickel iron and troilite) have more or less angular outlines and incline toward elongated forms. The nickel iron and troilite are usually intimately joined, although grains of each mineral also occur alone. The troilite readily recognized by its bronze yellow color, is more abundant that the nickel iron.

A few opaque grains of black color closely associated with the nickel iron and troilite are probably to be referred to chromite. Besides these, translucent grains with the typical red color of chromite are numerous, and one observed has a square outline showing it to be a section either of an octahedral or cubic crystal. The chromite always occurs united to the other opaque minerals. The grains of nickel iron and troilite often inclose grains of silicates of small size.

On the whole the Ness County meteorite should probably be classed as a crystalline chondrite or Meunier's erxlebenite, although its chondritic nature is somewhat doubtful.

As is probably generally known, a number of small aerolites quite similar to the one here described have been found in Ness County. The first of these found was briefly described by Henry L. Ward. Aside from this description and mention of the stones in one or two catalogues, no further account of them seems to have been published. Since Preston has suggested, however, that the Ness County stones may belong to the same fall with Kansada, Jerome, Prairie Dog Creek, and Long Island, a knowledge of them is desirable as a ground of investigating the suggestion. What additional facts I have been able to gain regarding the Ness County stones in general have been kindly given me by Mr. Henry L. Ward. In all at least twenty-five small aerolites have been found in Ness County, exclusive of Kansada. In weight they range, so far as Mr. Ward has been able to record them, from 34 to 3,467 grams, the total weight being 17,011 grams. This does not represent the entire amount, since of some stones Mr. Ward was unable to obtain exact record, but at least this amount has been found. The majority of these, so far as their place of find has been recorded, have come from the neighborhood of Franklinville, a village about 5 miles south of Ness City. The first one described by Mr. Ward, however, came from a place nearly 20 miles to the east of Franklinville, the exact locality being given by Mr. Ward as sec. 2, T. 20 S., R. 21 W. The village of Wellmanville is not far from this locality and this aerolite may therefore be called the Wellmanville stone.

The meteorite is distributed; Ward possesses 13.267 grams.

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Newberry County. See Ruffs Mountain.

NEW CONCORD.

Muskingum County, Ohio.
Here also Guernsey County.
Latitude 40° 2′ N., longitude 81° 46′ W.
Stone. Veined intermediate chondrite (Cia) of Brezina; Aumalite (type 37, subtype 1), of Meunier.
Fell 12.45 p. m., May 1, 1860; described 1860.
Weight: Over 30 stones, the heaviest weighing 103 lbs. Total weight about 227 kgs. (500 lbs.).

The first account of this great fall was given by Andrews, Evans, Johnson, and Smith,[1] as follows:

About 15 minutes before 1 o'clock on the 1st day of May, 1860, the people of southeastern Ohio and northwestern Virginia were startled by a loud noise, which was variously attributed to the firing of heavy cannon, to the explosion of steamboat boilers, to an earthquake, and to the explosion of a meteor. In many cases houses were jarred. To persons within doors the noise generally seemed as if produced by the falling of a heavy soft body upon the chamber floor. Many persons heard a rumbling reverberation which continued for a few seconds. The area over which this

explosion was heard was probably not less than 150 miles in diameter. At Marietta, Ohio, the sound came from a point north or a little east of north. The direction of the sound varied with the locality. An examination of all the different directions leads to the conclusion that the central point from which the sound emanated was near the southern part of Noble County, Ohio.

At New Concord, Muskingum County, where the meteoric stones fell, and in the immediate neighborhood, there were many distinct and loud reports heard. At New Concord there was first heard in the sky, a little southeast of the zenith, a loud detonation, which was compared to that of a cannon fired at the distance of half a mile. After an interval of 10 seconds another similar report. After two or three seconds another, and so on with diminishing intervals. Twenty-three distinct detonations were heard, after which the sounds became blended together and were compared to the rattling fire of an awkward squad of soldiers, and by others to the roar of a railway train. These sounds, with their reverberations, are thought to have continued for two minutes. The last sounds seemed to have come from a point in the southeast 45° below the zenith. The result of this cannonading was the falling of a large number of stony meteorites upon an area of about 10 miles long by 3 wide. The sky was cloudy, but some of the stones were seen first as "black specks," then as "black birds," and finally falling to the ground. A few were picked up within 20 or 30 minutes. The warmest was no warmer than if it had lain on the ground exposed to the sun's rays. They penetrated the earth from 2 to 3 feet. The largest stone, which weighed 103 pounds, struck the earth at the foot of a large oak tree, and after cutting off two roots, one 5 inches in diameter, and grazing a third root, it descended 2 feet, 10 inches into hard clay. The stone was found resting under a root which was not cut off. This would seemingly imply that it entered the earth obliquely. It is said that other stones which fell in soft ground entered the earth at a similar angle. They must have been flying in a northwest direction. This fact, added to the other facts that the detonations heard at New Concord came lower and lower from the zenith toward the southeast, and that the area upon which the stones fell extends with its longer axis in a southeast and northwest direction, would imply that the orbit of the meteor, of which these stones are fragments, extended from southeast to northwest. This conclusion is confirmed by many witnesses who saw, at the time, a luminous body moving in the same direction. It is a fact of some interest that the large stones were carried by the orbital force further than the small ones, and were found scattered upon the northwest end of the area referred to. This fact is readily explained by the larger proportional surface presented to the atmospheric resistance in the smaller stones. The stones thus far found vary in weight from a few ounces to over a hundred pouuds. They show a decided family resemblance. All are coated with a black crust and show a bluish gray feldspathic interior with numerous brilliant points of nickeliferous iron. Although in some instances the edges remain quite sharply defined, generally they show that they have been rounded by fusion. A figure shows the appearance of the larger stone now in the cabinet of Marietta College. Viewed from most positions this stone is angular and appears to have been recently broken from a larger body. On one side it is much rounder and smoother, and this (the outer surface in the figure) appears to be a part of the original surface of the main meteor. Two of its edges extend more than a foot in length, and two of its diameters are 14 inches. In the small stones the edges are more rounded than in the larger ones. A figure represents the appearance of a small stone, one side of which shows a surface only partially glazed. There was evidently a flaw in this little meteorite, and the heat entering the crack was only sufficient to fuse the surface in a very slight degree. The heat apparently penetrated the crack in straight lines, as if driven backward by the high velocity. The edge of the stone surrounding this peculiar surface is a feather edge made by the melting of the metallic crust in an unusual manner.

In the examination of this interesting meteoric phenomenon I am led to believe that the people of New Concord and in the immediate vicinity of the district where the stones fell heard different sounds, and consequently of different origin, from those heard by people living at a greater distance. The former heard many distinct detonations followed by a rumbling roar like that of thunder. The latter heard but a single explosion followed by a somewhat similar rumbling noise but less distinct. This explosion seemed to take place at a point in the air over the southern part of Noble County. The people of the northern part of the same county heard it in a southern or southeastern direction, and *not in a northwestern direction toward New Concord.* This fact would indicate that the great explosion which was heard more than 75 miles away, took place in Noble County, and that the several distinct detonations heard at and near New Concord were directly connected with the falling of the several stones in that district.

PROFESSOR EVANS'S COMPUTATIONS.

Owing to the cloudy state of the atmosphere the time was unfavorable for observing such facts as are necessary for the accurate determination of the height of the meteor, the direction of its path, its size, and its velocity. After careful investigation, however, the following results have been obtained:

1. *Direction of its path.*—The district along which the meteorites are known to have fallen is about 10 miles long and from 2 to 3 miles wide, extending in a northwesterly direction from a little west of the village of Point Pleasant, in Guernsey County, to within a mile of New Concord, in Muskingum County. The fragments fell with a northwesterly inclination. This is proved both by the testimony of those who saw them descend and by the direction in which they were subsequently found to have penetrated the earth. As the sky along this district was overcast with clouds, the main body of the meteor was not seen by those who witnessed the fall of the fragments; but the sounds, as heard by them, first proceeded from the zenith and gradually receded toward the southeast. This seemingly contradictory fact agrees perfectly with the hypothesis that the course of the meteor was northwesterly; for if it approached with a velocity greatly exceeding the velocity of the sound, the explosions which occurred last must have been the first heard. At some distant stations toward the south and west the view was not wholly obstructed by clouds; and there

are many witnesses who relate that a few minutes before any report was heard they saw a large ball of fire pass across the northern sky toward the northwest. By tracing out the line along which the reports were loudest and seemed to proceed from the zenith, I am led to the conclusion that the meteor passed over the eastern end of Washington County, then across the interior of Noble County, then over the southwestern corner of Guernsey and northeastern corner of Muskingum, with a direction of about 42° west of north.

2. *Its height above the earth.*—Mr. William C. Welles, of Parkersburg, Virginia (lat. 39° 10′, long. 81° 24′), a gentleman of liberal education, testifies that being about 3 miles east of that place at the time of the occurrence he happened to look up to the northeast of him, and saw a meteor of great size and brilliancy emerging from behind one cloud and disappearing behind another. When about 35° east of north he thinks its altitude was 65°. Now the distance in a direction 35° east of north from his station to the line directly under the meteor's path is 20 miles. Calculating from these data I find for the vertical height, taken to the nearest unit, 43 miles. This was to a point in Washington County near the border of Noble.

Mr. C. Hackley testifies that he saw the meteor from Berlin in Jackson County. It crossed a cloudless space in the northeast, and he thinks its altitude at the highest point was 30°. Now the distance from Berlin to the nearest point under the meteor's path is 70 miles. These data give nearly 41 miles for its vertical height over Noble County, a few miles to the south of Sarahsville (lat. 39° 53′, long. 81° 40′).

Many other reliable witnesses have been found who saw the meteor through openings in the clouds from various points west of its path, and whose testimony so far agrees with the foregoing as to give results ranging between 37 and 44 miles. Care has been taken as far as possible to verify the data in each case by personal examination of the witnesses. The angles have in most instances been taken as pointed out by them from their respective posts of observation. It is unfortunate that no case has come to our knowledge in which the meteor was seen from the region east of its path. But it was a circumstance in some respects favorable to the definiteness of the observations made from the west side that the observers in nearly all cases saw the meteor only at one point, or within a small space on the heavens. It is impossible to reconcile the various accounts without granting that its path was very nearly as above described, and that its height did not vary far from 40 miles as it crossed Noble County.

In regard to the time which intervened, at different places, between seeing the fireball and hearing the report, the statements are so vague that not much reliance has been placed upon them. It may be remarked, however, that they will essentially agree with the foregoing conclusions if we suppose that the loudest explosion took place in the southern part of Noble County.

I will add under this head the statement of Mr. Joel Richardson, of Warren, Washington County, who from a place 6 miles west of Marietta saw the meteor as much as 15° or 20° west of north at an altitude of about 45°. The direction in this case was so oblique to the meteor's path that the data are of little value for simply determining the height, but they are important on account of their connection with the place of the meteor's last appearance. Mr. Richardson was visited by the writer and his testimony was subjected to close scrutiny. If we take the azimuth at 15° west of north we shall have a distance of 41 miles to the line under the meteor's path, and these data will give 41 miles for its vertical height over a point not more than a mile from New Concord at the extreme western limit of the district along which the meteorites are scattered. If we take the azimuth at 20° west of north both the distance and the height will be greatly augmented. I have found two persons living near Bear Creek, 9 miles north of Marietta, who make statements closely corroborating that of Mr. Richardson.

3. *Velocity of the meteor.*—Mr. Welles furnishes data from which we can now determine approximately the meteor's rate of motion. As this gentleman is somewhat accustomed to astronomical observation his judgment as to angles may be strongly relied upon. He thinks he saw the meteor pass from a point 50° east of north to a point 20° east of north in about 3 seconds. These two points in the meteor's path are over the townships of Newport in Washington County, and Elk in Noble County. The distance between them is 12 miles. According to these data, then, its relative velocity was about 4 miles a second. No other statement regarding the velocity has been obtained that is sufficiently definite to be of any value.

4. *Its size and shape.*—Those who saw the fireball from stations not less than 20 and not more than 30 miles to the westward agree in stating that it appeared as large and as round as the full moon. Its intense brilliancy may have produced exaggerated conceptions of its size. But if we take the minimum apparent diameter of the moon and the minimum distance of the meteor (its height being assumed as 40 miles) we shall have for its diameter thirty-eight one hundredths, or about three-eighths of a mile.

The train is described as a cone having its base upon the fireball. As seen from near Parkersburg its length was estimated at twelve times the diameter of the ball. The part next the base appeared as a white flame but not so bright as to render the outline of the ball indistinct. About half way toward the apex it faded into a steel blue.

NOTICE OF THE FALL FROM D. M. JOHNSON, ESQ., OF COSHOCTON, OHIO.

(Mr. Johnson's notice of this shower of meteoric stones is the result of a visit to the locality a few days after the event.)

Two carpenters, Samuel L. Hines and Samuel M. Noble, were at work near the house on the farm of Jonas Amspoker, of New Concord. Upon hearing the first report they looked up and saw two dark-looking objects, apparently about the size of an apple, come through a cloud, producing a twirling motion in the vapor of the cloud. One of them they saw fall to the ground about 150 yards from where they stood. The other one passed behind the house out of their sight. They went immediately to the one they saw strike the ground and found it at the bottom of a hole 2 feet deep.

When taken out it was still warm and in a few seconds dried the moist earth adhering to its surface. It was found to weigh 51 pounds.

Nathaniel Hines, who was plowing in a field adjoining Mr. Amspoker's place, heard a report like the blasting of rocks in a well followed by several smaller reports. He looked up and saw a black body descending to the earth at an angle of about 30° to the vertical. It struck the ground about 200 yards from him. Repairing to the place he found that in its descent it came in contact with the corner of a fence, breaking off the ends of the three lower rails and entering the ground about 18 inches. It was warm and had a sulphurous smell. This stone was not weighed but it is estimated to have been between 40 and 50 pounds in weight before any portions were broken off from it. This was probably the stone that the carpenters saw but lost sight of when it passed behind the house.

James M. Reasner was in his house at the time of the explosion, but hearing a noise like striking against the door with the fist he went out, when his attention was attracted by a whizzing sound overhead. Looking up he saw what appeared to be a black streak descending in a slanting direction toward the earth. After he heard that stones had fallen in that vicinity he sought for and found a stone weighing 36½ pounds.

William Law was in his house, 1 mile east of Concord. Upon hearing the first report he went out into the yard. He heard a buzzing sound passing over the house in a northwest direction and saw the sheep running in a field not far from the house. Hearing that stones had fallen he went to the field in which the sheep were and found a stone weighing 53 pounds. It had fallen upon the end of a partially decayed log, through which it passed and buried itself in the ground. This was the largest stone that had been found at the time I visited the district. But I since learn that the one described by Professor Andrews was found after my visit to the place.

A blazing meteor was seen from other parts of the State on the same day. The *Columbus Statesman* of May 5 says that "near McConnellsville several boys observed a huge stone descend to the earth which they averred looked like a red ball, leaving a line of smoke in its wake." McConnellsville is 25 miles south of Concord.

Mr. D. Mackley, of Jackson County, in a communication to the *Cincinnati Commercial*, says, "On the 1st day of May at precisely half past 12 o'clock I was standing on the platform at the railroad station in Berlin when I saw, in a northeast direction, a ball of fire about 30° above the horizon. It was flying in a northerly direction with great velocity. It appeared as white as melted iron and left a bright streak of fire behind it which soon faded into a white vapor. This remained more than a minute, when it became crooked and disappeared." Berlin is about 80 miles southwest of Concord.

The meteor seen from McConnellsville and Berlin was undoubtedly the same that exploded and fell in Guernsey County. No one of the many persons who saw the stones fall and were in the immediate vicinity at the time noticed anything of the luminous appearance described by those who saw it from a distance.

All the stones that I have yet seen have the same general appearance. They are irregular blocks, and are covered with a very thin crust which looks as if it had been fused. The edges of the blocks are not sharp but rounded, and the faces present the usual pitted appearance of meteorites. They absorb water with a hissing sound. The fragments are of a bluish-gray color. Under the lens five substances can be detected. A snow-white mineral is largely disseminated throughout the mass. A clearer white mineral can be distinguished in some specimens. Metallic grains are quite numerous, a yellowish brown mineral in patches, and black particles scattered over the surface. One specimen had very thin veins of a shining black mineral. When in large masses the stone is exceedingly tough, requiring repeated blows of a hammer to fracture it, and when broken into small pieces it can be crushed with ease in an agate mortar.

The specific gravity of the mass was found to be 3.5417. On analysis one gram of the stone was found to contain:

Silica	0.51250
Protoxyd of iron	.25204
Magnesia	.08873
Alumina	.05325
Lime	.00785
Iron	.08803
Nickel	.02360
Sulphur	.01184
Chromium	Trace.
Phosphorus	Trace.
Water	.00035
	1.03819

Coshocton, Ohio, *June 4, 1860.*

Prof. J. Lawrence Smith, M. D., of Louisville, Kentucky, informs us that on hearing vague rumors of the event two days after its occurrence (reported as an earthquake accompanied by a fall of stones), and although 400 miles distant from the place, he immediately visited New Concord and obtained all possible data respecting the phenomenon. He is convinced from a thorough examination of the facts that no fall of meteoric stones before recorded possesses so many points of interest as the one in question, surpassing even the far-famed fall of L'Aigle. He reserves many details of the event with his chemical examination for a paper in the next number of this journal. The analyses, so far as they are complete, show the constitution of the New Concord stones to be identical with those that fell about the same time last year, March 28, 1859, in Indiana.

Thus far about 30 stones have been recovered from this fall, and one witness estimates the entire weight of the fragments discovered at about 700 pounds.

The fine specimen secured by Professor Andrews for Marietta College is, we believe, the largest meteoric fragment hitherto recorded as existing in one piece. Professors Silliman and Kingsley estimated the weight of a fragment of the Weston meteorite (1807) which was dashed in many pieces by falling on a rock as about 200 pounds.

Shepard [2] gave the following description of one of the stones:

Through the much valued assistance of Prof. J. L. Smith, the large 53-pound stone that fell near the house of Mr. William Law, of New Concord, forms part of my meteoric cabinet. Without attempting at present a complete description of its form and character, I will only offer a few remarks upon the relationship of the Ohio meteorites to those of other falls. In its internal aspect it approaches the stone of Jekaterinoslaw, Russia (1825), though it is somewhat firmer and more compact. In crust the two are identical. It is also similar to the stone of Slobodka, Russia (August 10, 1808); and compares closely with those of Politz (October 13, 1819), of Nanjemoy, Maryland (February 10, 1828), and of Kuleschowka, Russia (March 12, 1811); but the crust is less smooth on the Ohio stone than in that of the latter.

A pearl gray peridot forms the chief constituent (about two-thirds) of the stone. This mineral is often rolled up into obscurely formed globules, which are so firmly embedded in the more massive portions of the same mineral, as to be broken across on the fracture of the stone, which thereby presents a subpisiform appearance. Snow-white particles of chladnite are thickly scattered in mere specks through the mass, and closely incorporated with the peridot. The nickelic iron, of a bright white color, is also everywhere thickly interspersed in little points. Pyrrhotine is less conspicuous, though often visible in rather broad patches; while black grains of chromite are easily distinguished by the aid of a glass, and sometimes with the naked eye.

The crust is of medium thickness, and the usual wavy and pitted impressions are also strictly characteristic of these stones. Their origin in meteorites generally is perhaps still obscure, but may be conceived to originate in the flaking off of fragments in consequence of the sudden transition from cold to hot, which must happen to bodies coming instantaneously from a temperature far below zero into a state of vivid incandescence, at least upon their immediate surface. We see a somewhat analogous flaking up from heated surfaces of granite blocks during a conflagration, when wetted by cold water; though in the latter case, as might be expected, convexities take the place of concavities.

Evans [3] gave a further account of the meteor, as follows:

Since writing my communication published in the July number of the American Journal of Science on the path and height of the New Concord meteor, I have found some additional data, which I regard as important because they have been furnished by a good observer who saw the meteor under favorable circumstances. A single case of the kind is the more worthy of note because, owing to the cloudiness of the day when this meteor passed, there were but few places from which it was seen at all. The observer referred to is D. Mackley, Esq., a lawyer of Jackson, Ohio, who, at the time of the occurrence happened to be at Berlin, about 6 miles northeast from the former place, and 70 miles from the nearest point under the meteor's path. He took pains to note all the facts as accurately as he could at the time; and he afterwards returned to the spot in order to determine more definitely the points of the compass. His testimony, in answer to my interrogatories, is substantially as follows:

"The meteor first appeared to me at a point about 55° east of north. It moved northward in a line very nearly parallel with the horizon. When it disappeared it had described an arc of about 15°. It was in sight about 6 seconds. Its altitude was about 30°. In regard to its size, I have since looked at the sun through a thin cloud, and I think the apparent diameter of the meteor was one-half that of the sun."

These data give the meteor a height of 41 miles over the northern boundary of Noble County; a diameter of three-eighths of a mile; and a relative velocity of nearly 4 miles a second. The results agree sufficiently well with those before given.

The meteor was seen through openings in the clouds at various points along a line of 60 miles, extending from near Newport, on the Ohio River, to the neighborhood of New Concord. The evidence, upon the whole, does not indicate any descent of the body toward the earth between these limits, or any change in its size or appearance. From this fact and the great height of the body, and the absence of all evidence that it was seen or heard in the northern part of the State or beyond, it seems probable that this meteor was not dissipated in the atmosphere, but passed out of it again. The shower of stones that came down near New Concord had probably been detached from the principal mass before the latter came into sight.

A complete account was given by Smith,[4] as follows:

These meteorites were first called Concord meteorites, as the one first described was found near the village of New Concord, but I have thought proper to call them the *Guernsey County Meteorites*, since we are commonly in the habit of distinguishing the meteorites found in this country by the name of the county in which they fell or were found. All but one of the great number of meteoric stones that fell on this occasion were found in Guernsey County, and that exceptional specimen fell in Muskingum, on the edge of Guernsey County.

This fall of meteorites was the most remarkable ever observed in this county, and equal to, if not surpassing, the famous fall at L'Aigle, in France, with which it has many points of interest in common that will be stated in the course of this paper.

My attention was first directed to this occurrence by a short notice of it in a newspaper as being an earthquake that had occurred in eastern Ohio, accompanied with a shower of stones. Suspecting the true nature of the phenomenon, I immediately visited the spot where it was said to have occurred, and collected the statements of those persons who had witnessed the fall. It was ascertained that on Tuesday, May 1, 1860, remarkable phenomena transpired in the heavens, and the following are the accounts given by different observers, men of intelligence and observation.

Mr. McClenahan states that at Cambridge, in Guernsey County, Ohio (latitude 40° 4′, longitude 81° 35′), about 20 minutes before 1 o'clock p. m., three or four distinct explosions were heard, like the firing of heavy cannon, with an interval of a second or two between each report. This was followed by sounds like the firing of musketry in quick succession, which ended with a rumbling noise like distant thunder, except that it continued with about the same degree of intensity till it ceased. It continued two or three minutes, and seemed to come from the southwest, at an elevation above the horizon of 30° to 40°, terminating in the southeast at about the same elevation. In the district where the meteorites fell the explosions were heard immediately overhead.

The first reports were so heavy as to produce a tremulous motion, like heavy thunder, causing the glass in windows to rattle. The sound was so singular that it caused some excitement and alarm, many supposing it an earthquake. At Barnesville, 20 miles east of Cambridge, the cry of fire was made, as the rumbling sound was thought to be the roaring of fire.

The day was cool and the sky covered at the time with light clouds. No thunder or lightning had been noticed that day, nor could anything unusual be seen in the appearance of the clouds. Immediately on hearing the report this observer looked in the direction it came, and noticed the clouds closely, but could not see anything unusual.

The next morning it was reported in Cambridge that aërolites had fallen on a farm in the vicinity of New Concord (8 miles west, a little south of Cambridge). Inquiries were immediately instituted, and Messrs. Noble and Hines state that they were near the house of a Mr. Amspoker at the time of the first explosion, which seemed directly over their heads. They looked up and saw two objects apparently come through the clouds, producing a twirling of the vapor of the cloud at the point where they came through, then descending with great velocity and a whizzing sound to the earth, one striking about 300 yards to the southwest of them, and the other about 100 yards north.

They immediately went to the spot where the first fell, and found it buried 2 feet in the ground. They dug it out and found it quite warm and of a sulphurous smell. The other struck a fence corner, and breaking the ends of some of the rails penetrated into the earth 16 or 18 inches, passing through a heap of dry leaves. The first weighed 52 pounds. The other was broken up, but must have weighed about 40 pounds. Another of 41 pounds weight, not seen to fall, was discovered at the bottom of a hole 2 feet deep, where it had fallen on stiff turf, and was seen at the bottom of the hole, having carried the sod before it. It must have come from the southeast at an angle of 60° with the horizon. Many were discovered to have fallen southeast of Cambridge, but of smaller dimensions than those already referred to. At the time of the occurrence, nearly all were at dinner or in or about their houses. The stones obtained were mostly found near houses, where they were seen to fall, as the sound of their striking the ground attracted attention.

Another well-informed observer, Doctor McConnell, of New Concord (a small town 8 miles east of Cambridge), furnishes the following particulars: "On Tuesday, the 1st of May, at 28 minutes past 12 o'clock, the people of that vicinity were almost panic-stricken by a strange and terrible report in the heavens which shook the houses for many miles distant. The first report was immediately overhead and after an interval of a few seconds was followed by similar reports with such increasing rapidity that after the number of 22 was counted they were no longer distinct, but became continuous and died away like the roaring of distant thunder, the course of the reports being from the meridian to the southeast. In one instance three men working in a field, their self-possession being measurably restored from the shock of the more terrible report above, had their attention attracted by a buzzing noise overhead and soon observed a large body descending strike the earth at a distance of about 100 yards. Repairing thither they found a newly made hole in the ground from which they extracted an irregular quadrangular stone weighing 51 pounds. This stone had buried itself 2 feet beneath the surface and when obtained was quite warm."

To this we add the following statement: "We, the undersigned, do hereby certify that at about half past 12 o'clock on Tuesday, May 1, 1860, a most terrible report was heard immediately overhead filling the neighborhood with awe. After an interval of a few seconds a series of successive reports, the most wonderful and unearthly ever before heard by us, took place, taking a direction from meridian to southeast, where the sounds died away like the roaring of distant thunder, jarring the houses for many miles distant." Signed by A. G. Gault, James McDonald, Nancy Mills, Ichabod Grumman, Samuel Harper, Rev. James C. Murch, Mrs. M. Speer, Angie McKinney.

The above is from those who heard the noises but did not see the fall; the following are a few statements of the many I collected from those who witnessed the fall of the stones. I extract from their depositions made at the time:

"I heard the reports and roaring as above described and a few seconds afterwards I saw a large body or substance descend and strike the earth four or five hundred yards from where I then stood; and then I, in company with Andrew Lister, repaired to the spot, and about 18 inches beneath the surface found a stone weighing 50 pounds." Signed, Samuel Reblu.

"Heard the reports and roaring as above described; and the said Mrs. Fillis further says that a few seconds afterwards she heard a descending buzzing noise as of a body falling to the ground. And Miss Cherry also says that she was standing near Mrs Fillis, heard the same and saw some substance descend and strike the earth some hundred yards distant, and that Mrs. Fillis repaired to the spot and there found a stone 18 inches beneath the surface weighing 23 pounds." Signed by Agnes Fillis and Mary J. Cherry.

"I distinctly heard the roaring and sounds as above described and a few seconds after the above report I saw descending from the clouds a large body that struck the earth about 150 yards from where I then stood, and I immediately repaired to the spot and about 2 feet beneath the surface found a stone weighing 42 pounds. A second or two after seeing the first stone I saw another descend and strike the earth about the same distance from where I stood. I also took the last-mentioned stone from the earth about 2 feet beneath the surface. Both the above stones when taken from the earth were quite warm. I also saw a third stone descend." Signed, Samuel M. Noble.

One observer saw a stone fall within 3 feet of his horse's head. One of the most southerly stones struck a barn, while some people retired within doors for fear of being struck.

These, with many others of a similar nature, were the data obtained near the region of the fall of stones. It is important to remember that to these near observers no luminosity or fireball was visible.

In addition to the above facts we have the following from observers at more distant points, as already published by Professors Andrews and Evans. From the data they have collected they consider the area over which the explosion was heard as probably not less than 150 miles in diameter. "At Marietta, Ohio, the sound came from a point north or a little east of north. The direction of the sound varied with the locality. An examination of all the different directions leads to the conclusion that the central point from which the sounds emanated was near the southern part of Noble County, Ohio," its course being "over the eastern end of Washington County, then across the interior of Noble County, then over the southwestern corner of Guernsey and the northeastern corner of Muskingum, with a direction of about 42° west of north."

Mr. D. Mackley, of Jackson County, states that he was at Berlin, 6 miles east of Jackson, Ohio, when he saw in a northeast direction a ball of fire about 30° above the horizon. It was flying in a northerly direction with great velocity. It appeared as white as melted iron and left a bright streak of fire behind it, which soon faded into a white vapor. This remained more than a minute when it became crooked and disappeared.

Mr. Wm. C. Welles, of Parkersburg, Virginia (latitude 39° 10′, longitude 81° 24′), about 60 miles south of Cambridge, saw the meteorite as a ball of fire of great brilliancy emerging from behind one cloud and disappearing behind another. Other observers at some distance to the south of the point where the fall occurred saw this meteorite as a luminous body.

* * * * * * * * *

The time of day and the number and intelligence of the observers unite to give considerable interest and value to these observations. While some of them show points of difference, natural to the observation of sudden and startling phenomena, we can yet deduce from them many conclusions with more or less accuracy, thus:

THE DIRECTION OF THE METEORITE.

My own observation of two of the stones which fell half a mile apart enables me to give the direction of the meteor with some degree of exactness. The first of these stones struck the ends of the rails of a Virginia (zigzag) fence half way down, just touching the middle rail, breaking off more and more of each rail as it passed to the ground. Connecting the points of fracture by a line this line represents a descending curve from southeast to northwest.

Again, the stone that fell at Law's (the most northerly) struck a large dead tree lying on the side of a hill sloping northwest, passing through it as any projectile would; it then struck a small clump of elders, breaking them off at the root, falling finally at the foot of a hill. A line connecting these points shows the curve already stated. Coupling with this the observations of Mr. Callahan on the direction that one of these stones penetrated the ground with the observed path of their distribution no doubt can remain that the general direction of the fall was from southeast to northwest, striking the ground at an angle of about 60°.

ALTITUDE OF THE METEORITE.

This is a point that can be determined but very imperfectly, if at all. It may have been, when first seen, 40 miles above the earth, but when the explosion was heard it must have been nearer and was even still nearer when it subdivided and was scattered ("exploded," as usually termed) over Guernsey and the edge of Muskingum Counties.

TEMPERATURE OF THE STONES.

Several of the largest stones were picked up 10 minutes after their fall and are described as being about as warm as a stone that had lain in the sun in the summer. One fell among dry leaves that covered it after it had penetrated the ground. The leaves, however, showed no evidence of having been heated. No appearance of ignition was discovered in places or objects with which the stones came in contact at the time of their fall, so that their temperature must have fallen far short of redness, while it may not have reached that of 200°.

SIZE AND VELOCITY.

I have no data upon which to calculate either of these. Professor Evans, however, as just quoted, calculates from the data above given that its size was three-eighths of a mile and velocity 4 miles a second.

While I may furnish no more reliable computations from the data obtained, I may be excused a short criticism upon the above results to prevent too hasty conclusions being formed.

As regards the supposed elevation of 40 miles *when the first reports were heard* I would simply ask the question, Is it possible, with the established views of the conduction of sound by rarefied air, that any conceivable noise produced by a meteorite 40 miles distant from the earth in a medium quite as rare if not rarer than the best air pump can produce,

would reach us at all, or, if so, in the manner described by observers? This question is a more important one to consider, as some observers on similar data have calculated the elevation of meteorites when they were first heard to explode at 100 miles.

As regards the size of the meteorite, I have but to refer the reader to my experiments made in 1854 and published in 1855 to show the perfect fallacy of calculating the size of luminous objects by their apparent disks, and I shall have more to say on the same subject in a future paper. It is important to note that the nearest approach of the meteor to the earth must have been in the northern part of Noble and in Guernsey Counties, the point from which its most wonderful display seemed to have manifested itself; yet we hear nothing of its future career by reports from observers north of this, while its approach from the south to this point was noticed by a number of observers.

I need hardly state that my own convictions are that the meteorite terminated its career in Guernsey County, and that the group of stones which constituted it were scattered broadcast over that county. Many have been collected and many lie buried in the soil to molder and mingle their elements with those of the earth.

We come now to consider the stones that fell and were collected. Their number was over 30 and their places of falling have been plotted with some care on a map.

The localities of 24 have been fixed with precision by the assistance of the Hon. C. J. Albright * * *. The largest were at the northwest extremity and the smallest at the southeast. The space over which they were scattered was about 10 miles long by 3 miles broad. The following is a catalogue of 24:

No.	Weight, pounds.	Fell on the farm of—
1	103	Shenholt.
2	56	Law.
3	52	Amspoker.
4	50	Amspoker.
5	41	Torrence.
6	36	Reasoner.
7	23½	Hodges.
8	26	Fillis.
9	16	Adair.
10	15	Craig.
11	8¼	Craig.
12	4½	Waller.
13	4	Beresford.
14	3¾	Craig.
15	3¾	Stevens.
16	3¾	Wall.
17	3	Walker.
18	2¾	Claysville.
19	2	Stevens.
20	2	Wall.
21	2	Savely.
22	1	Carter.
23	1	Heskett.
24	½	Heskett.
	460¾	

Others have been found, but I have no correct record of their exact position. Some fifteen of these stones have come under my observation. They are all irregular in shape, cuboidal, wedge-shaped, globular, and every conceivable form that irregular fragments of stone may be supposed to possess. They all have the well-known black coating, with a sharp outline between the coating and gray mass of the stone, and there is quite a uniformity in the character of the coating in both small and large stones.

When broken this meteor exhibits a gray mass, with metallic particles of nickeliferous iron, resembling the stones I examined that fell in Harrison County, Indiana, on the 28th of March, 1859. The latter, however, is the coarser-grained of the two.

The general thickness of the crust is about from one-thirtieth to one-fortieth of an inch.

Several specimens have been examined. They all show the presence of the same minerals, with a slight variation in their proportions, as might be expected in a mass not homogeneous. Its composition is fairly represented as follows: Specific gravity, 3.550, varying slightly in different specimens. In 100 parts there are—

Nickeliferous iron	10.7
Earthy minerals	89.3
	100.0

The nickeliferous particles separated by a magnet from the crushed stone, and well washed, presented the following constituents in 100 parts:

Iron	87.011
Nickel	12.360
Cobalt	.421
Copper, minute quantity, not estimated.	
Phosphorus	.012
Sulphur	1.080
	100.884

The sulphur comes from the magnetic pyrites that the meteorite contains, and is not easy to separate mechanically from the small particles of nickeliferous iron.

The earthy part, when freed as thoroughly as possible from nickeliferous iron (which can be done pretty effectually by the magnet), was treated with warm dilute muriatic acid, thrown on a filter first washed thoroughly with water, then with a solution of potash to dissolve the last portion of the silica of the decomposed portion of the mineral. The result was, in 100 parts:

Soluble portion	63.7
Insoluble	36.3
	100.0

The earthy mineral analyzed as a whole was found to contain:

Silica	47.30
Oxide of iron	28.03
Alumina	.31
Magnesia	24.53
Lime	.02
Soda, Potash	1.04
Manganese	trace
	101.23

From these results it is very clear that the mineralogical constitution of these meteoric stones is about as follows, in 100 parts:

Nickeliferous iron	10.690
Schreibersite	.005
Magnetic pyrites	.005
Olivine	56.884
Pyroxene	32.416
	100.000

This sums up the history of this meteoric shower, with as full an account as possible of the stones that fell at that time. In the first part of this paper it was stated that this fall was quite as remarkable as that near L'Aigle, in France, in 1803. Although it does not equal this latter in the number of stones that were collected, it exceeds it in size of the stones that fell. The largest of the L'Aigle stones weighed 17½ pounds, while the largest in the present case was 103 pounds.

There are many points of coincidence in the phenomena and circumstances attending the two falls. Were I to copy Biot's description of the phenomena of the fall at L'Aigle, as detailed to the Academy of Science nearly 60 years ago, it would be but a repetition of what has been written in the first part of this paper.

The date of the fall at L'Aigle was the 26th of April; the date of the Guernsey fall May 1. Time of the day of the former, one o'clock; of the latter twenty minutes of one; the direction of both falls, from southeast to northwest. The extent of surface covered by the first, 7½ miles long by 2½ broad; by the latter, 10 miles long by 3 wide; and both were seen by a large number of persons.

Evans [5] gave a further account of the meteor and in part replied to the criticisms of Smith as follows:

In a brief account of this meteor published in the American Journal of Science, July, 1860, I gave the most reliable and definite observations which I had been able to collect, bearing on the question of the meteor's path and velocity; I also gave such conclusions as the data seemed to me to warrant. I propose now to review the subject more at length, in the light of all the facts now in my possession; partly in order to state, in a more careful manner, both my conclusions and the arguments by which they seem to me to be established; and partly in order to correct some serious errors in regard to the data, which appear in former communications on this subject.

Prof. J. L. Smith, of the University of Louisville, in an article published in the January number of the American Journal of Science begins by summing up "all the observations" which he considers "worthy of note respecting the fall of this meteorite." In this summary, the statement is repeatedly made, that the village of New Concord, near

which the largest stones fell, is nearly east from the village of Cambridge, at which some of the observations which he records were made; it is also stated that a large number of stones fell southeast of Cambridge. The truth is that New Concord is nearly west of Cambridge, and that not one of the stones has yet been found to have fallen southeast of the latter place.

On the map contained in Professor Smith's article, the lines of latitude place the fall of meteoric stones full 60 nautical miles farther north than it really occurred; while Parkersburg, the place of a most important observation, quoted by him, is placed too far north by about 37 nautical miles. Such errors, if allowed to stand uncorrected, would involve the whole subject of the meteor's path in confusion.

Among the observations which Professor Smith selects as noteworthy I find the following: "Mr. D. Mackley, of Jackson County, states that he was standing on the platform of the railroad station in Berlin, 20 miles south of Parkersburg, when he saw in a northeast direction a ball of fire about 30° above the horizon," etc. The value of this observation will appear when it is considered that there is no railroad passing through any place 20 miles south of Parkersburg, that there is no place named Berlin in that part of Virginia, and that the village of Berlin from which Mr. Mackley saw the meteor is in the State of Ohio, nearly 50 miles west of the point indicated by Professor Smith. The quotation is substantially in Mr. Mackley's own words (as reported from the *Cincinnati Commercial* by D. M. Johnson, in the American Journal of Science, July, 1860), with the exception of the words "20 miles south of Parkersburg," which are added. This mistake is the more unaccountable, because in Mr. Johnson's communication the place of observation is described as 80 miles southwest of Cambridge, while both in Mr. Mackley's letter to the *Commercial* and in my more complete report of his testimony, from which Professor Smith elsewhere quotes, the place is precisely designated as Berlin, 6 miles east of Jackson, Ohio. But the statement, when corrected, is not of more consequence than several others which Professor Smith omits altogether from his list of observations worthy of note; though he afterwards gives them in part, as having been relied upon by Professor Andrews and myself.

In commenting upon my conclusions, Professor Smith says: "As regards the supposed elevation of 40 miles when the first reports were heard, I would simply ask the question, is it possible, with the established views of the conduction of sound by rarefied air, that any conceivable noise, produced by a meteorite 40 miles distant from the earth, in a medium quite as rare if not rarer than the best air pump can produce, would reach us at all, or if so, in the manner described by observers?"

I need only say in reply that the writer here attempts to invalidate my conclusions by throwing doubt on premises from which I reasoned. That the sounds in question were somehow connected with the fall of stones none will deny. That they proceeded from an elevation of 40 miles is a view which might well be received with doubt; it is certainly a view which I never maintained. How the sounds were caused, whether by violent disruption of parts or otherwise, is a question which it would be foreign to the purpose of this article to discuss; but I may state in this connection one important fact relating to them, because I shall have occasion to refer to it again. The successive reports heard at great altitudes in the districts where the stones fell, and apparently connected with the descent of the separate pieces through the clouds, were entirely distinct from the one great detonation which was heard at great distances from that district. The former were distinclty heard only over an area of a few miles. The latter shook buildings from Wheeling, Virginia, to Athens County, Ohio. It is ascertained by careful inquiries to have been heard from Columbiana County on the northeast to within 8 miles of Chillicothe on the southwest, and from Knox County on the northwest to the borders of the third tier of counties in Virginia on the southeast, an area of about 150 miles in diameter. At all places within this area, except those near Cambridge and New Concord, it was described as a single sound, a sudden concussion resembling thunder or the discharge of a heavy piece of ordnance, followed by a roar of about 2 seconds in continuance. A merchant of Marietta, happening to be at dinner, suspected it was the explosion of a powder magazine in his store about a quarter of a mile distant. The Parkersburg *News* says: "The houses shook as with an earthquake." In the counties of Washington, Morgan, Noble, Monroe, and Belmont, and in places along the Virginia side of the Ohio River from Parkersburg to Wheeling, those who were within doors very generally attributed it to an earthquake. The windows rattled, and local papers state that the door of an engine house was jarred open at Bellair, near Wheeling. The lines of direction of the sound from all sides, as distinguished by those who happened to be out of doors, cross each other in the southern (not far from the central) part of Noble County, while the inhabitants of the region thought it was overhead. Professor Andrews, giving the results of personal inquiries, says: "The people of the northern part of Noble County heard it in a southern or southeastern direction, and not in a northwestern direction toward New Concord." At Zanesville, about 12 miles from New Concord, the *Courier* described the noise, not as a succession of sounds, but as an "explosion." These facts clearly indicate that the great detonation heard at these various places was one and the same sound, and that it proceeded from a point over the interior of Noble County. The most probable location is 5 or 6 miles south of Sarahsville. It was undoubtedly the *first produced*, but the *last heard*, of the successive sounds described as receding to the southeast by witnesses in the neighborhood where the meteoric stones fell, and it was compared by them to the roar of thunder.

Again, Professor Smith says: "As regards the size of the meteorite, I have but to refer to my experiments made in 1854, and published in the American Journal of Science of 1855, to show the perfect fallacy of calculating the size of luminous objects by their apparent discs."

As the above remark is made in reference to my estimate of the size of the meteor, it is but justice to myself to say that I had acknowledged the danger of error from this source, and had only insisted that if the apparent disc and the estimated distance be *assumed* as data, we shall obtain for the diameter of the meteor about three-eighths of a mile.

I may now proceed to the discussion of the meteor's path, and first of all I shall aim to state the data with as much accuracy as possible. It is proper to say that the latitudes and longitudes of places in my first communication on this subject were inserted by the editors, apparently from common maps. I shall here give latitudes, longitudes, and relative distances of places as nearly as they can be determined from the most reliable surveys of this part of Ohio yet made, which, so far as the distances are concerned, may be supposed near enough for the purpose in view. The accompanying map is on too reduced a scale to be easily made accurate; but it will aid the reader in understanding the following remarks.

In my former estimates I decided upon that path which seemed to agree best with all the observations then known to me. After more thorough investigation, it seems better to give first the results formed from a few observations which there is now reason to consider the most reliable, and then to show how nearly the other observations confirm these.

The witnesses on whom I shall most rely are William C. Welles, of Parkersburg, a graduate of Nassau Hall, and D. Mackley, Esq., a lawyer of Jackson, Ohio. My reasons for this selection are: First, the superior intelligence of the witnesses; secondly, their favorable places of observation, one at a great distance from the meteor's path and the other comparatively near; and finally, the great pains taken by each to note the facts accurately on the spot, with a view to publication. I may add also that I have subjected both these witnesses to close examination.

Mr. Welles's place of observation was in the State of Virginia (latitude 39° 17′, longitude 81° 24′), about 3 miles east of Parkersburg. His testimony is as follows: He saw the meteor through an opening in the clouds, first appearing about 50° east of north, and disappearing 20° east of north. It was in sight about 3 seconds. Its altitude when 35° east of north was about 65°. Of this he is most confident. When asked at what altitude its visible path produced would cut the meridian to the north of him, he pointed from 50° to 55°. It is important to observe that Mr. Welles's judgment as to angles is to be strongly relied upon, because he is somewhat accustomed to astronomical observations.

Mr. Mackley's place of observation was Berlin (latitude 39° 6′, longitude 82° 23′), about 6 miles nearly northeast of Jackson, Ohio. His testimony is as follows: He saw a brilliant meteor pass over a cloudless space from about 55° east of north to about 40° east of north. It was moving nearly parallel with the horizon. When it first appeared, its altitude was about 30°; at its disappearance it was about 2° lower. It was in sight about 6 seconds. Mr. Mackley's account of the manner in which he estimated the angles serves to strengthen confidence in his accuracy. He says that as nearly as he could judge the meteor appeared at one-third of the distance from the horizon to the zenith, and the arc which it described, when projected on the horizon, would be one-half the altitude. He states also that he visited the place again in order to determine, as accurately as possible, the points of the compass.

In order now to make a first approximation, let us assume that the path of the meteor, when projected on the earth, would pass through New Concord (latitude 40° 1′, longitude 81° 45′), on either side of which the heaviest stones fell. The bearing of this line, as shown by the direction of the route along which the stones were scattered, by the direction in which different pieces are ascertained by Professors Andrews and Smith to have reached the ground, and by the direction to which the successive reports attending their fall receded, must have been nearly northwest. Let us then suppose, by way of trial, that it was exactly northwest. Mr. Mackley saw the meteor from Berlin in a northeast direction. Now these two directions being at right angles to each other, it follows that its real path was nearly parallel with the earth's surface, for otherwise its apparent path could not, under the given conditions, have been nearly parallel with the horizon, as Mr. Mackley declares it was. It follows also that its height above the earth was not far from 40 miles, for the altitude given by Mr. Mackley is from 28° to 30°, and the distance northeast from Berlin to the projection of the supposed path upon the earth is about 70 miles.

We may now proceed to correct this first approximation by combining the observations of Messrs. Mackley and Welles. We may assume that the path of the meteor for a short space, such as these two observers saw it traverse, could not have departed very far from a straight line; for it was moving in the highest regions of the atmosphere, and, according to any hypothesis, with immense velocity. Then the line which will best agree with the observations of both, and at the same time, when projected on the earth, pass through New Concord, runs 40° west of north. Let us first consider Mr. Welles's observation—azimuth 35° east of north, altitude 65°. The base line in this case (from Mr. Welles's station to the supposed projection) is 19 miles; the consequent height 41 miles nearly. This was at a point over the eastern part of Washington County. Next, take Mr. Mackley's first observation—azimuth 55° east of north, altitude 30°. The base line in this case is 68 miles, and the consequent height (after allowing for the curvature of the earth) 40 miles. This was over the southern part of Noble County. Next, consider Mr. Mackley's second data—azimuth 40° east of north, altitude 28°. The base line is about 69 miles, and the resulting height 38 miles nearly. This was over the northern border of Noble County. Now, by comparing the distances between these stations with the corresponding differences of height, it will be seen that they are not far from proportional, which gives a trajectory between the above limits, not departing far from a straight line though descending somewhat more in the last part than in the first. But if we suppose the bearing to have been one or more degrees greater or less than 40° west of north, we shall in like manner obtain, from the same observations, a trajectory departing from a straight line altogether too rapidly to be admissible; in the one case, indeed, convex toward the earth, in the other case rising and falling successively within the limits of the atmosphere.

The path now found is consistent with Mr. Welles's approximate estimate of the altitude (from 50° to 55°) at which the arc described by the meteor would, when produced, cut the meridian. In the statements of other witnesses we find as close agreement with those of Messrs. Mackley and Welles as could be expected from ordinary observers of sudden and startling phenomena. In the neighborhood from 8 to 10 miles north of Marietta a considerable number of persons

(I mention Jacob Leonhart and two sons, of Bear Creek) caught glimpses of the meteor through the clouds, north and a little west of north, at such altitudes as to show that if its course was nearly northwest its height was not far from 40 miles over the central and northern parts of Noble County. Many persons in the eastern border of Athens County, west of Marietta, saw the meteor in a northeasterly direction passing from cloud to cloud at such altitudes as lead to the same conclusion. Mr. John Brabham and several others undertook to show the angle at which the body was descending toward the horizon and it was such as to give a path not differing widely from the above when combined either with Mr. Welles's observation or with that of Mr. Mackley. The statements of different observers at the same places of course vary somewhat, but none have been used except those which seemed well attested. The directions were taken whenever possible, as pointed out by observers themselves, from their places of observation. Every case of very wide discrepancy in testimony was by this means made to disappear.

Let us now use the data furnished by Messrs. Welles and Mackley for estimating the velocity of the meteor. It is to be observed that its bearing, as above estimated, being so nearly at right angles with the lines of vision of both observers, reduces the velocity almost to a minimum. Now Mr. Welles saw the meteor pass from 50° east of north to 20° east of north, a distance of 11 miles, in about three seconds. This gives for its velocity in the first part of its visible path 3⅔ miles in a second. Mr. Mackley estimated that the meteor was visible to him for six seconds. The distance in this case is 18 miles; the consequent velocity 3 miles a second. Here is as close agreement as could be expected, and in view of the tendency to exaggerate the time we may presume that neither of these estimates of the velocity is too great; but of the two that based on Mr. Welles's observation should be preferred, since the shorter interval of time is the easier to estimate with precision.

There is no strong evidence that the meteor was seen farther southeast than where it first appeared to Mr. Welles, nor farther northwest than where it was last seen by Mr. Mackley. The distance between these two points projected on the earth is about 35 miles. In a former communication I gave the testimony of Joel Richardson, of Warren, as tending to show that it was seen over the district where the stones fell; but from comparison of his statements with those of others in the same neighborhood I am disposed to admit that he made an error of 10 or 15 degrees in the direction. Rumors of persons in Morgan County having seen the meteor descend nearly to the horizon have, upon investigation, proved groundless.

It was a circumstance favorable to correct estimates of directions, on the part of observers, that they saw the body through openings in the clouds. From the east side of its path it was not seen at all, as the sky was completely overcast, but no pains have been spared to collect and examine all the observations from the west side by personal communication with the witnesses.

The conclusions which we have derived from the evidence may now be briefly summed up as follows: The course of the meteor was about 40° west of north. It was first seen over the eastern part of Washington County (about lat. 39° 27′, lon. 81° 8′) at a height of 41 miles, nearly. It was last seen over the northwestern border of Noble County (about lat. 39° 51′, lon. 81° 34′), at a height of 38 miles, nearly. Its velocity relatively to the surface of the earth was from 3 to 4 miles a second.

As the time was half past 12, noon (May 1), it follows from the results just given that its velocity in the solar system was from 20⅓ to 21 miles a second.

As the data can not be claimed to be more than approximations to the truth the conclusions can not. I have given the results found by comparing the data of two excellent observers at advantageous posts as the most likely to be near approximations. These results agree nearly with my first estimates, formed by a general comparison of less select data, before the most material statements in Mr. Mackley's testimony or any part of the testimony of Mr Brabham and many others were yet known to me. Any attempt to establish a path differing widely from that now given, whether in the bearing or in the height above the earth, or in the amount of departure from parallelism above the earth's surface between the points indicated, will cause the statements, not only of Messrs. Mackley and Welles, but of all the observers, to clash hopelessly with each other.

These views are entirely inconsistent with the hypothesis that the whole of the blazing body described by witnesses came to the earth in Guernsey County. If the principal mass fell at all it must have fallen at a great distance beyond. Whether we suppose it was consumed in the air or passed on there is no difficulty arising from the fact that it was not seen farther to the northwest, for there is evidence that the sky along its path was overspread with clouds not only from Northwestern Virginia to New Concord but to a considerable distance beyond; and I have ascertained from meteorological reports recorded in the Smithsonian Institution that there were clouds (early in the afternoon, May 1) over a large part of northwestern Ohio. Nor is there any difficulty in conceiving how different bodies of the same density, after entering the atmosphere together and moving through it a great distance, could have been so far separated. For the smaller bodies having more surface in proportion to their weight than the larger (the surfaces being as the squares of the diameters while the solidities are as cubes) would encounter more resistance from the air. And the smaller bodies, having once fallen below the larger, would receive a still further acceleration to their descent from the increased density of the air; for it is an established fact that through atmospheric strata of equal depth the increase in density downward is by a geometrical ratio. In order, however, to account for a separation of over 30 miles in a vertical line it is necessary to concede that the part which passed over was much larger than any of those which came to the ground. It must also be conceded that they began to separate long before crossing the Ohio River, a view which is strongly supported by the fact already stated that over the southern part of Noble County the stones which fell had already descended far enough to cause a concussion in the lower atmosphere that was heard over a vast region.

Madelung [6] gave the following analysis:

SiO_2	40.391
FeO	18.133
MgO	23.510
Al_2O_3	2.300
CaO	2.523
Fe	5.778
Ni	0.235
Fe_2O_3	5.819
NiO	0.812
Mn	trace
	99.501

These ingredients are grouped as follows:

	Nickel iron.	Soluble silicates.	Insoluble silicates.	
SiO_2	.....	18.944	21.447	
FeO	.....	18.133	.....	
MgO	0.094	15.616	7.800	
Al_2O_3	.....	.....	2.300	
CaO	.....	.....	2.523	
Fe	5.778	.....	.....	
Ni	0.235	.....	.....	
Fe_2O_3	.....	.....	5.819	
NiO	.....	0.812	.....	
Mn_2O_3	.....	.....	trace	
Total	6.011	53.505	39.889	=99.405

Rose [7] mentioned the gift of an individual of this fall weighing 26 pounds to the Berlin collection by J. Lawrence Smith. He also mentions chondri 3 to 4 lines in diameter and remarks that the stones take a good polish.

Reichenbach [8] has a single reference to the fall, describing a black vein in one specimen as follows:

> The Muskingum specimen in the Göttingen museum has a black vein which runs through the entire stone and is broken off in places, and then affords upon five little specks dark gray striped cracks with metallic luster. A sixth place of the same sort and glistening is crossed at right angles with the first.

Wright [9] obtained gases from a specimen of the meteorite as follows:

Temperature:	Co_2	Co	CH_4	H	N	Volume.
500°	82.28	2.16	2.26	12.37	0.93	2.06
Red heat	16.79	8.71	1.66	69.43	3.41	0.93
Total	59.88	4.40	2.05	31.89	1.78	2.99

Wadsworth [10] classified the meteorite as a peridotite and made the following observations:

> A crystalline granular rock containing pyrrhotite and iron and showing yellowish brown spots of staining around the latter.
>
> Section: A light-gray crystalline mass of olivine, pyroxene, and enstatite, and containing iron and pyrrhotite. The groundmass is stained a yellowish brown in many places.
>
> The enstatite, pyroxene, and olivine are in clear grains when unstained, and are much fissured and broken.
>
> Some of the enstatite shows the same structure as the chondri of other meteorites except that it wants the cementing base. That is, these grains are formed from minute grains arranged in rodlike forms and lying side by side. The iron and pyrrhotite is in irregular masses and granules. Some colorless irregular patches were observed giving a pale color in polarized light and resembling nephelite.

Brezina [11] classified the meteorite in 1885 as intermediate chondrite, but later [12] as veined intermediate chondrite.

The meteorite is distributed. Marietta College has the 103-pound stone and Amherst the 51-pound and 34-pound stones. Harvard has 29.361 grams; London, 19,519 grams.

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New Jersey. See Deal.

Newton County. See Mincy.

NIAGARA.

Grand Forks County, North Dakota.
Latitude 47° 56′ N., longitude 97° 50′ W.
Iron. Coarse octahedrite (Og) of Brezina.
Found 1879; described 1902.
Weight, 115 grams (4 ozs.).

This meteorite was described by Preston,[1] as follows:

This iron was found 2 miles southeast of Niagara, Grand Forks County, North Dakota, in the early part of August, 1879, by Mr. F. Talbot, who discovered it while making a collection of the various rocks and minerals on his father's ranch.

It measured 30 by 40 by 50 mm. and weighed 115 grams. It was very much oxidized, of a brownish-black color, and showed no trace of the original crust whatever. In sawing it crumbled into small fragments of from 2 to 4 or 5 grams weight each. The largest piece obtained weighed 26 grams.

On etching two pieces composed of unoxidized iron, an octahedral structure was strongly brought out in the Widmannstätten figures, the kamacite plates being somewhat broad, with a second series of markings of hairlike lines upon them about the size of the Neumann lines on the Braunau iron.

Analysis (Davison):

Fe	Ni	Co	
92.67	7.37	0.13	=100.17

Specific gravity, 7.12.

The meteorite is distributed.

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NOBLEBORO.

Lincoln County, Maine.
Latitude 44° 3′ N., longitude 69° 28′ W.
Stone. Howardite (Ho) of Brezina.
Fell 4.30 p. m., August 7, 1823; described 1824.
Weight, 2 to 3 kgs. (4 to 6 lbs.)

The first mention of this meteorite was by Cleaveland,[1] as follows:

This aerolite fell at Nobleboro, Maine, August 7, 1823, between 4 and 5 o'clock p. m., on land belonging to John and David Flogg. The following account of the phenomena was received from Mr. A. Dinsmore, who was at work near the place on which the aerolite struck.

Mr. Dinsmore's attention was excited by hearing a noise which at first resembled the discharge of platoons of soldiers, but soon became more rapid in succession. The air was perfectly calm; and the sky was clear, with the exception of a small whitish cloud apparently about 40 feet square, nearly in his zenith, from which the noise seemed to proceed. After the explosion, this little cloud appeared to be in rapid spiral motion downwards, as if about to fall on him and made a noise like a whirlwind among leaves. At this moment the stone fell among some sheep which were thereby much frightened, jumped, and ran into the woods. This circumstance assisted Mr. Dinsmore in finding the spot where the stone struck, which was about 40 paces in front of the place where he was standing. The aerolite penetrated the earth about 6 inches and there meeting another stone was broken into fragments. When first taken up, which was about one hour after its fall, it exhaled a strong sulphurous odor. The whole mass previous to its fracture probably weighed between 4 and 6 pounds. Other fragments of the same meteoric stone are said to have been found several miles from Nobleboro.

A chemical examination of a fragment of the stone was made by Webster[2] and published in the Philosophical Magazine. His account is as follows:

This aerolite fell at Nobleboro, in the State of Maine, on August 7, 1823, between 4 and 5 o'clock p. m. (Here follows an abstract from Professor Cleaveland's report of an interview by some second party—"a gentleman of intelligence"—with Mr. A. Dinsmore, who was at work near the place where the aerolite struck.)

I obtained a specimen of the meteorite from Dr. Geo. Hayward. Externally the specimen was in part covered with a thin, semivitrified crust or enamel of a black color, the surface of which was irregular and marked with numerous depressions, presenting every appearance of having been subjected to intense heat. The crust was hard, yielding with difficulty to the knife. The quantity of this crust afforded by the small fragments examined was not sufficient to allow of any separate analysis of it.

The mass of the specimen had a light gray color interspersed with oblong spots of white, having the aspect of decomposed leucite and giving it a porphyritic appearance. Throughout the stone minute points of a yellow substance, resembling olivine, were distributed, with microscopic points of a yellow color, which I took for sulphuretted iron. The cement by which these substances were united was of an earthy aspect and soft texture, readily broken down by the fingers. The general appearance of the mass was precisely like that of some of the volcanic tuffas.

The specific gravity was remarkably low, being but 2.08.

Before the blowpipe it exhaled a sulphurous odor, but was not fused.

The substance was reduced to powder and subjected to a magnet of considerable power, but no attractable particles were separated. A portion was heated to redness on a platinum spoon; it emitted the sulphurous odor, and its weight was diminished rather more than 21 per cent; the residue acquired a brown color; it was again presented to the magnet, but nothing was attracted. [Here follows a detailed description of the process of analysis.]

The composition of this meteoric mass is therefore:

S	Silex	Al	Lime	Mg	Cr	Fe	Ni	Loss	
18.3	29.5	4.7	trace	24.8	4.0	14.9	2.3	1.5	=100.00

Brayley[3] remarked that the meteorite resembled those of Luotolax, Jonzac, and Juvenas. Chladni[4] opposed this view, however, on account of the presence of nickel in Nobleboro and other differences of composition.

Partsch[5] described the meteorite as very similar to Luotolax. It differs only, he says, in being less coherent.

Shepard[6] gave the following description:

The crust is a perfectly fused and shining glass similar to the Juvenas and Stannern stones. The color of the interior is a light ash gray. When examined by the aid of a lens, it is found to be highly composite in character, although the small fragment in my possession shows neither nickel-iron nor magnetic pyrites. The most abundant ingredient is howardite, through which are disseminated grains of greenish transparent olivinoid, white particles of anorthite, black grains of chantonnite, and a red-colored, vitreous, hard mineral which appears to be either garnet or idocrase.

Buchner[7] gave the specific gravity 3.092, as determined by Rumler, and remarks that the value 2.08, given by Webster, is probably a typographical error for 3.08. He also doubted the correctness of Webster's analysis.

Maskelyne[8] gave the following note:

Since the text was in press I have had an opportunity, through the civility of Professor Shepard, of inspecting a small fragment of the Nobleboro stone. It is a curious aerolite. More like Bialystok than Maessing or Manegaum, it is rich in a very black and opaque substance (probably two such substances), one of which is like the dark augite in the Eukritic aerolites, and especially in Juvenas. There is much of a colorless mineral as well as of olivine, of every tint from pale yellow to yellowish-brown; and the opaque white mineral above alluded to is abundant. There is also a small amount of iron, and of what seems to be troilite. The crust is an enamel with fine luster. The transparent, colorless mineral may possibly be a feldspar (anorthite?), but it requires further scrutiny.

Rose [9] grouped Nobleboro with Luotolax as a howardite, but stated that the Berlin specimens were too small for further study.

Reichenbach [10] expressed doubt of the correctness of Webster's analysis and described Nobleboro as holding a middle position between two other classes, the first of which consists of finely rounded globules, the second of angular, sometimes sharp-edged, irregular, and more or less broken fragments. Nobleboro and others like it, he says, are composed of globules and broken fragments placed side by side.

Wadsworth [11] classified Nobleboro as a peridotite and described it as fragmental in character, closely resembling a trachytic or rhyolitic ash. He remarks that Webster's analysis is probably incorrect and that the meteorite ought to be reëxamined chemically and studied microscopically.

Brezina [12] grouped the meteorite as a howardite.

Wülfing [13] records the existence of only 78 grams of the meteorite, of which 60 grams are possessed by the University of Halle. He remarks the desirability of an analysis.

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Nuevo Leon. See Coahuila.

OAKLEY.

Logan County, Kansas.
Latitude 38° 55′ N., longitude 101° 0′ W.
Stone. Crystalline chondrite (Ck) of Brezina.
Found 1895; described 1900.
Weight, 27 kgs. (61 lbs.).

This meteorite was described by Preston,[1] as follows:

The aerolite described in this paper was found 15 miles southwest of Oakley, Logan County, Kansas, by Charles Hicks, in the spring of 1895. He discovered it at a depth of about 3 feet below the surface, while plowing on his farm.

Mr. Hicks states that it fell on February 20, 1894, about 11 p. m., and seemed to come from the northeast. It did not appear to burst before striking the earth, and, as stated above, was found by him the following spring. As to the date of fall of this meteorite Mr. Hicks is certainly mistaken, as will be shown later on. The mass passed from Mr. Hicks into the hands of Prof. G. H. Failyer, of Manhattan, Kansas, from whom Prof. H. A. Ward, of Chicago, purchased it in December, of 1899.

Its weight, when received by Professor Ward, was 61 pounds 10 ounces, and was 7.5 by 10 by 12 inches in its greatest diameters. One side of the mass was covered entirely with the original crust, a large portion of it being of a dull black color, interspersed with numerous patches of yellowish-brown rust spots, due to the oxidation of the iron. The opposite face showed the interior of the mass, a large flake, covering nearly three-quarters of the surface, having been broken off evidently at the time the mass struck the earth, as the surface was much oxidized and had the appearance of a very old break. Again, two-thirds of the edges were chipped, showing old fractures; while a large portion of the face showing crust, with several of the fractured surfaces on the edges, were coated with a very thick deposit of carbonate of lime. This could not have been deposited during the time that elapsed between the date of the fall, as

given by Mr. Hicks, and the time it was found by him; on the contrary, it must have lain in the position where found a very long period of time in order to become thus thickly coated by the lime.

The larger surface of the mass showing crust is very smooth, entirely free from the customary pittings, except on one edge, of a thickness of 7.5 inches, where large prominent and characteristic pittings are present.

On slicing the meteorite we find that the groundmass is compact and grayish-black in color, more or less spotted with much darker blotches or streaks, and abundantly flecked with bright iron grains. The largest of these observed was 6 mm. in diameter; in the center of it is a small troilite nodule 1 mm. in diameter. On the polished surfaces numerous grains of troilite are visible, which form a strong contrast by their bronze-yellow color to the white nickeliferous iron.

The sections have also numerous fissures extending across their surfaces following somewhat the rounded outline of the exterior of the sections. These fissures were probably caused by the contact with the earth's crust at the time of its fall.

By carefully powdering and repowdering 18 grams of this stone and separating the iron from the silicates by a magnet we found the ratio of the metallic part to the silicates as follows:

Metallic part	Fe	12.76
	Ni + Co	1.68
		14.44
Silicates		85.56
		100.00

An analysis of the metallic part by Mr. J. M. Davison, of Reynolds Laboratory, gave—

Fe	89.16
Ni	10.84
	100.00

Specific gravity, 3.7.

Dr. Geo. P. Merrill, of the United States National Museum, to whom I sent a few fragments of this stone, kindly made sections of some and examined them for me. "He found that the stone belongs to the chondritic olivine-enstatite type, though the chondritic structure to the unaided eye is somewhat obscure, well-defined, spherical chondrules being few and widely scattered. In general appearance it closely resembles the Pipe Creek, Bandera County, Texas, aerolite but is of finer grain. Under the microscope it presents no features not common to aerolites of this class—olivine and enstatite chondrules embedded in a very irregularly granular groundmass of the same materials with numerous particles of metallic iron and iron sulphides. The chondri present the characteristic barrel (or grate) and fan-shaped structures and are often themselves fragmental. The structure is on the whole very obscure, and more closely resembles that of Pipe Creek, as above mentioned, than any other of which we have slides. No silicate, other than olivine and enstatite, could be determined in the slides, but the solution obtained by digesting the powdered stone in dilute hydrochloric acid contained a trace of lime and alumina, suggesting the presence of a lime or a lime-soda feldspar."

The stone would thus belong to the Meunier type 34, Erxlébénite.

Its nearest prominent geographical point being Oakley. It will be designated as the *Oakley meteorite* (Logan County, Kansas).

The meteorite is somewhat distributed, but chiefly (8,910 grams) in the Ward-Coonley collection.

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Oaxaca. See Misteca.

Old Fork. See Jennies Creek.

Oldham County. See Lagrange.

Ophir. See Illinois Gulch.

OROVILLE.

Butte County, California.
Latitude 39° 27′ N., longitude 121° 30′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1893.
Weight, 24 kgs. (54 lbs.).

No description of this meteorite seems to have been published. Wülfing[2] notes it as catalogued by Bement.[1]

The main mass was in the museum of the Academy of Sciences of San Francisco before the fire of 1906.

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OSCURO MOUNTAIN.

Socorro County, New Mexico.
Latitude 33° 50′ N., longitude 106° 35′ W.
Iron. Coarse octahedrite (Og) of Brezina.
Found 1895; described 1897.
Three masses of 3.5, 3.25, and 1.25 pounds weight (1,467, 1,226, and 676 gms). Total, 3.4 kgs. (8.5 lbs.).

This meteorite has been described by Hills[1] as follows:

The Oscuro Mountain meteorite, here described, is the third independent occurrence of the kind recently announced from south central New Mexico.

The Oscuro iron was discovered near the eastern base of the Oscuro Mountains, a north and south range lying about 40 miles west of the Sacramento Range and parallel with it. Nothing is known as to the date of the fall, though the fresh, lively appearance of the surfaces does not suggest a great lapse of time.

For the first intimation of its existence I am indebted to Mr. H. A. Gross, superintendent of the New Mexico Development Co., who, suspecting its true character, succeeded in securing a small piece which he submitted to me while on a professional trip into that country about a year ago. An effort was then made to obtain possession of the balance of the find and Mr. P. Nicol, an intelligent employee of the company, was instructed to proceed to Three Rivers and if possible negotiate for the remainder. In this he was finally successful.

Owing to pressing engagements I could not personally investigate the history of the find and requested Mr. Gross to do so. As I have been intimate with him for many years I have the utmost confidence in the results of his careful inquiry into the matter. Writing under date of July 23, 1896, he says:

"The discovery was made by Phillippe Montoya, a Mexican sheep herder living at Three Rivers, Lincoln County, New Mexico, on or about December 10, 1895. It consisted of three irregular-shaped pieces weighing about 3.5, 3.25, and 1.25 pounds, respectively, the small piece having been subsequently cut in two and somewhat damaged.

"The locality where it was found is in the eastern foothills of the Oscuro Mountains, in Socorro County, New Mexico, at a point on the south side of a small conical hill composed of gypsum and limestone. This hill is readily distinguishable from others in the vicinity in that it has a considerably broken-up limestone cap, about 150 feet across and nearly round and flat on the top. It lies about 2.5 miles west of the Lincoln County malapais and about 10 miles due west from the "bar W" ranch of the Carrizoza Cattle Co. The hill is also somewhat marked by considerable shallow digging and prospecting done by the finder in search for more of the material which he supposed was native silver.

"The pieces were found on the south hillside about 2 feet, 3 feet, and 5.5 feet apart in a straight line in nearly an east and west direction—the largest piece being below and the smallest piece above and about 20 feet down from the top of the hill. In conjunction with Mr. P. Nicol, who was with me and had been there before with the finder, I looked very closely around in the vicinity for any more but was unable to find anything that might have any relation to the meteorite.

"The first piece was obtained by me on December 15, 1895. On March 27, 1896, Mr. Nicol secured the two large complete specimens from Phillippe Montoya himself. About May 1, 1896, Mr. Nicol got the remaining piece. I consider we have it all, as represented by the Mexican who was strongly tempted for any more he might find. Neither of the small pieces had been in possession of more than the second person before we got them and Montoya says we have all he found of it."

The several pieces weigh approximately as follows:

No. 1, 1,467 grams; No. 2, 1,226 grams; No. 3, 676 grams. The first two are practically intact except the small portion removed for analysis. The third is in two fragments, of which the larger shows chisel marks and a coarsely crystalline surface of fracture, while the smaller shows chisel and vise marks and has evidently been heated, presumably in a forge. As the two fragments do not fit together there can be no doubt that some portion is missing and it is probable that the heating was resorted to in order to facilitate the cutting off of small pieces for the purpose of crude experiment intended to reveal the nature of the substance. The quantity of the material thus sacrificed can hardly be conjectured. If the mass was separated in the first place into two nearly equal portions and what was thought to be the smaller was subjected to further subdivision, which seems probable, as much as 200 grams may have been destroyed or rendered worthless.

The form and general appearance, as well as the prominence of the "thumb marks," are well shown in photo-etchings of the two specimens. The surfaces exhibit no evidence of weathering and the thin dark-brown crust appears to be intact, except that in the depressions where it is somewhat thicker than on the protuberances minute cracks are discernible with a lens. A reproduction of the etched figures, printed direct from a small slice treated with bichloride of mercury solution, shows very prominently the stronger lines of tænite; while with a lens the finer lines present in one of the triangular patches can be detected even in the print. Irregular patches of granular texture containing minute scales of graphite are likewise prominently distributed through the bands of kamacite. Troilite was

not observed in any of the slices prepared but schreibersite is undoubtedly present, as indicated not only by the analysis but by the presence in one slice of a rectangular section of this substance about 3 mm. across surrounded by a border of the graphite-bearing iron. A little of the mineral which remained with the companion slice, broken out in the form of powder by means of a sharp-pointed instrument, afforded a heavy precipitate of ammonium phosphomolybdate when treated in the usual way.

The irregular lines noticeable in the etching are caused by cracks which penetrate more or less deeply into the mass.

An analysis of shavings taken from one of the specimens photographed gave the following result:

Fe	Ni	Co	P	C	
90.79	7.66	0.57	0.27	0.07	=99.36

The carbon is in the form of graphite. The rather low summation is doubtless due to the fact that the edges of the shavings were not entirely free from traces of the oxidized material of the crust.

The meteorite is distributed.

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Otsego County. See Burlington.

OTTAWA.

Franklin County, Kansas.
Latitude 38° 37′ N., longitude 95° 18′ W.
Stone. Howarditic chondrite (Cho) of Brezina.
Fell Apr. 9, 1896.
Assignable weight, 111 grams.

Ward states that this meteorite was described in a copy of the Ottawa Weekly Times of April 16, 1896, but the present writer has not been able to secure the issue. No other description seems to exist. Ward possesses 111 grams.

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PACULA.

District of Jacala, State of Hidalgo, Mexico.
Latitude 21° 7′ N., longitude 99° 9′ W.
Stone. Brecciated white chondrite (Cwb), of Brezina.
Fell on the morning of June 18, 1881; described 1889.
Weight, 3,361 grams (7 lbs.).

This meteorite was first described by Castillo,[1] as follows:

This meteorite fell in 1876 (?) in the environs of the village of Jacala. There were found three fragments, weighing 3,361 grams, of which the largest weighed 2,115 grams. These fragments are composed of meteoric feldspar, red olivine, and disseminated meteoric iron. All are enveloped by a black, granular, rugose crust at the contact of which is found some troilite. The largest and smallest fragments are in the collection of Castillo.

Brezina[2] gave the following further description:

A white chondrite, breccialike; a stone with an inclination toward Cib, having moreover, the greatest similarity with Honolulu at all points where the abundant armor face formation prevails over the enlarging of crust veins to a black zone of alteration. The crust is deep black, somewhat lustrous; over an infiltration vein 1 cm. wide it has a rib-like fluting.

The meteorite is somewhat distributed; New York possesses 797 grams; Vienna, 266 grams.

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2. 1895: Brezina. Wiener Sammlung, p. 246.

PERSIMMON CREEK.

Near Hothouse, Cherokee County, North Carolina.
Latitude 35° 6′ N., longitude 84° 7′ W. (Ward).
Iron. Granular octahedrite (Ob), Tassin; finest brecciated siliceous octahedrite (OffbP) Klein.
Found 1893; described 1904.
Weight, 5 kgs. (11 lbs.).

The meteorite was described by Tassin,[2] as follows:

This meteorite was found on the farm of Mr. W. W. Young, on Persimmon Creek, in the southern part of Cherokee County, North Carolina, in the spring of 1893. Mr. Young disposed of it to Mr. Thorn Smith, chemist of the Isabella Copper Company, Isabella, Tennessee, from whom it was obtained for the U. S. National Museum. The date of its fall is unknown, but the appearance of the mass is such that it had lain in the soil a long time.

The weight of the main mass was 9 pounds 6 ounces. From this a fragment weighing 1 pound 13 ounces had previously been broken, making the entire known weight 11 pounds 3 ounces, or 5.014 kgs.

The mass is roughly triangular in cross section, with its surface deeply indented and much oxidized, so that the customary pittings are largely obliterated.

Outwardly the mass shows no characteristics of more than ordinary interest. In the polished section, however, the iron is seen to be of an unusual type. This shows it to be made up of a more or less continuous matrix of iron containing troilite, schreibersite, and carbon. The troilite areas vary in their maximum diameters from 1 mm. to 1.5 cm. Certain of these areas contain granular carbon in such quantities that the bronze yellow of the containing troilite appears only as specks through the carbon. In these graphitic areas a fairly abundant olivine is found. This silicate also occurs very sparingly in the nickel iron in minute granular aggregates. Schreibersite occurs sparingly, in a manner similar to the troilite. The largest of the schreibersite areas is 3 by 6 mm. along its greatest diameters, and, like the troilite, it contains carbon, but does not carry olivine. This phosphide occurs also in very thin plates bounding the iron masses, and between them and the troilite. It occasionally occurs in small grains or plates in the iron constituent, and is then arranged in dendritic or mosslike aggregates. Schreibersite also occurs in thin plates lineally arranged and resembling tænite.

Etching the iron constituent develops a band of bright white iron next to the troilite and schreibersite areas and bounding them. This alloy may be kamacite, but it was not possible to separate any of it to determine its composition. On each side of and bounding the white iron is a very thin plate standing in relief, which in certain instances is known to be schreibersite and in others tænite. The mass of the iron constituent is made up of a darker colored alloy or eutectic. In this eutectic are seen fine lines of a tin-white color, which are in part tænite, and which penetrate the mass in zigzag shapes. Examined under a glass the dark iron appears to be homogeneous, and to be made up of minute octahedrons arranged in fine lamellæ. The eutectic or dark iron does not contain any chlorides, and the very small amount of chlorides present was noted as occurring as lawrenceite between the bordering "white-iron" alloy. The Persimmon Creek iron may be classed as a granular octahedrite containing numerous troilite and some silicate areas. * * *

Schreibersite is present in pealike nodules and needles (rhabdite) of a tin-white color and specific gravity of 7.17. It yielded—

Fe	Ni+Co	P	
69.33	17.26	12.50	=99.09

The nickel iron gave—

Fe	Ni+Co	P	
85.00	14.50	1.00	=100.50

Olivine occurs in small granules of a yellowish-green color, and yielded—

SiO_2	MgO	FeO	
39.10	48.20	12.30	=99.60

Specific gravity, 3.39.
The carbon gave no evidence under the microscope of diamond or cliftonite.
The portion of the meteorite soluble in acid yielded—

Fe	Ni	Co	Cu	Mn	P	SiO_2	Al_2O_3	Pt	Mg	
94.36	3.723	0.25	0.29	0.01	0.27	0.809	trace	trace	trace	=99.712

The phosphorus may have been derived from dissolved schreibersite, or from an unknown phosphide, or from phosphorus in solid solution analogous to the conditions prevailing in certain manufactured irons. The silica and magnesia were derived from the olivine. The platinum, alumina, and magnesia contents were too small to weigh, and the first two may have been admitted during the analysis.

An end piece weighing 193 grams is thus described by Cohen:[1]

First to be noticed are numerous, frequently ragged and bent particles of troilite. They surround spangles and larger grains of nickel iron, as well as jagged, black particles which appear to consist of a small-grained aggregate of silicate particles with intermixed particles of troilite; a closer determination is not possible without preparation of thin sections. Small particles of the questionable silicate, free from troilite, occur also, for the most part isolated in

the nickel iron, although readily falling into groups. The nickel iron falls into very irregular masses often divided from the troilite by ragged and rounded outlines, the size of the concretions varying from a few millimeters to 3.5 cm. Such a specimen of nickel iron is bounded by a conspicuous, glistening band of kamacite about 0.2 mm. wide bordered with a film of tænite on each side, from which frequently processes run out into the nickel iron, sometimes in large meandering coils, again in small zigzag lines. Only where these kamacite-tænite bands border on troilite or on moderate masses of schreibersite is the tænite so lacking that the accessory constituents are surrounded by an envelope of kamacite which is bordered by tænite only upon outer faces. In all aggregates dense, dull, gray plessite predominates. In the smaller ones occasionally also it appears homogeneous under the microscope and then consists of tiny grains; frequently, however, it breaks up into minute lamellæ, which are grouped in extremely pleasing network, and are apparently arranged in conformity with the octahedrons. Many areas exhibit to the unaided eye small bright spangles or beautiful tracery, each branch of which consists of a tiny complete lamellæ. Larger concrete masses contain in varying number—always, however, in subordination—octahedral lamellæ 0.05 mm. in breadth which sometimes lie isolated, but are as a rule grouped in bundles. Such portions may be compared, from their formation, with Tazewell. In the neighborhood of the before-mentioned silicate masses the octahedral structure is interrupted, and here especially are found the twisted spiral kamacite-tænite bands, as if replacing the lamellæ.

Persimmon Creek is a granular octahedrite with framework of finest lamellæ which differentiates itself from the rest by the peculiar swathing of the grains, as well as by the troilite, which occurs as a sort of filling and in common with Copiapo has silicate particles.

The following further description is given by Klein[3] of a specimen in the Berlin collection:

Upon a plate 3.4 cm. long by the same width, after etching, there appear numerous small particles divided by a black substance which show the finest lamellæ of an octahedral iron. The remarkable thing about it is that these lamellæ upon one field form rectangles, upon another rhombic or triangular or irregularly four-sided figures.

The octahedral, nickeliferous iron is therefore met with in the individual portions and areas in the form of cubes, dodecahedrons, octahedrons, or other forms.

We have here then either a breccia with a variable orientation of the individual portions, or, as in the case of Mukerop, an intricate twinning according to the octahedral form. Closer investigation on a larger surface is required to distinguish this.

The iron contains magnetic iron sulphide (magnetic pyrites), in addition to particles of rhabdite and also dark, apparently siliceous inclusions. These consist of rhombic and monoclinic augite, doubtless also olivine, which on its part lies in a groundmass of pyrites or iron. In so far the iron resembles that of Netschaëvo on account of its mesosideritic inclusions, and is to be designated as OmN. It also approaches nearly to the brecciated, siliceous iron Of. b. K of Kodaikanal, but is different from that and must be regarded as a new species—Persimmon Creek. In respect to the octahedral irons it is one with finest lamellæ Off., while because of the brecciated structure it is b, and because of the siliceous character and total peculiarities is P, or as a whole, OffbP.

The meteorite is chiefly preserved in the United States National Museum.

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3. 1904: Klein. Sitzber K. Preus. Akad. Wissensch., vol. 32, p. 572.

Phillips County. See Long Island.

Pine Bluff. See Little Piney.

PETERSBURG.

Lincoln County, Tennessee.
Latitude 35° 18′ N., longitude 86° 35′ W.
Stone. Howardite (Ho.) of Brezina; type 47 of Meunier.
Fell 3.30 p. m. August 5, 1855; described 1856.
Weight, 1.7 kgs. (4 lbs.).

The first extended account of this meteorite was given by Shepard[2] as follows:

A brief account of this stone is contained in the Geological Reconnaissance of Tennessee by Prof. James M. Safford, the geologist of the State. I shall first give the substance of his account and then subjoin some observations of my own derived from an examination of the entire specimen which, through the kindness of Professor Safford, I have been permitted to make.

The particulars of the fall were communicated by the Rev. T. C. Blake, of Cumberland University. The stone, which at first weighed 3 pounds, fell 2 miles west of Petersburg, in Lincoln County, at about 3.30 p. m. August 5, 1855,

during, or just before, a severe rainstorm. Its fall was preceded by a loud report, resembling that of a large cannon, followed by four or five less reports. These were heard by many persons in the surrounding country. This stone was seen immediately after the reports to fall to the ground. The observer of its fall was James B. Dooley, Esq. It approached him from the east, appearing while in progress to be surrounded by a luminous halo 2 feet in diameter. It struck the ground only 150 yards from him and buried itself about 18 inches in the soil. When first removed it was still too hot to be handled. As first described by Professor Safford it had one edge broken, showing an ash-gray color within, varied by patches of white, yellowish, and dark colored minerals, while its surface was invested with a very thin black and shining crust as if it had been coated with pitch. One extremity of the stone has an irregular rhomboidal figure measuring 2¾ by 2½ inches. Placed upon this end the body presents the form of a slightly oblique and tolerably defined oblique rhombic prism 4½ inches long. The upper end, however, is not well formed but runs up to one side in a somewhat flattened edge. Three adjacent sides, including the base, are rough, being covered with cavities and pits, the others are smoother and rounded. The specimen acts upon the needle; fragments of it readily yield particles of nickeliferous iron by trituration in a mortar. The specific gravity of the entire mass is 3.20.

The following are the results of an examination and analysis made upon fragments of the stone by Prof. J. L. Smith, of the medical department of the University of Louisville. "The minerals present are pyroxene (the principal portion of the mass), olivine, and orthoclase (disseminated), and nickeliferous iron (forming about one-half per cent of the mass). In addition to these there are specks of a black shining mineral not yet examined. The general analysis is as follows:

Silica	49.21
Alumina	11.05
Protox. iron	20.41
Lime	9.01
Magnesia	8.13
Manganese	.04
Iron	.50
Nickel	trace
Phosphorus	trace
Sulphur	.06
Soda	.83
	99.23

I find the glaze to resemble, in its thickness and general character, that of the Stannern stones, but in its high degree of glossiness it approaches also the Juvenas meteorite. The figure is well described above as being that of a somewhat oblique rhombic prism. It might perhaps be added that at its upper or smaller end there is a tendency to a replacement of the two obtuse angles, each by a single plane, thus producing a sort of dihedral summit whose edge of course coincides with the longer diagonal of the base. The lateral planes, meeting under an obtuse angle, agree in being smooth, together with the replacing plane of the angle at the upper end of the obtuse edge. The corresponding planes, together with the base, possess a totally different character, being rough and deeply pitted. This is a property so general in meteorites as obviously to depend upon a general cause the nature of which, however, it is difficult to conjecture. Sometimes the deeply pitted or undulating surface is confined to two sides in place of extending to three or four, but it is nevertheless often visible upon at least one-third of the general area and occupies it without interruption of patches of the smoother kind of surface. The edges of the uneven planes are less perfectly defined than of the other planes, and this is particularly true of the meeting of the two larger ones in the present instance.

The heaviest end of this stone is of course toward its basal extremity. It is therefore natural to suppose that its motion must have been with this end in advance. It is curious to observe that there exists a series of delicate wavy lines traversing the crust of the stone from its base quite to its opposite smaller end as if they had been produced from the friction of the atmosphere upon its liquefied crust. Could the escape of electricity have had any influence also in producing such an appearance? The fact of the marking, however, is most obvious whatever may have been the cause.

Viewed near by the crust is seen to be somewhat variegated in color. Small specks of a yellowish brown and, more rarely, of a yellowish-white color interrupt very frequently the general pitchy hue of the glaze. These lighter-colored portions are translucent and are seen to arise from the character of the subjacent minerals which have undergone fusion.

The fresh fracture has an ash-gray color, with a slight intermixture of pearl gray for the basis of the stone. Three-fifths of the stone may be said to have this tint. Diffused through this occur rounded and polygonal patches (the largest half an inch in diameter, the smallest scarcely distinguishable by the naked eye) of a highly crystalline snow-white mineral. The former of these minerals I take to be anorthite; the latter is chladnite. The anorthite is often in four-sided, nearly rectangular prismatic crystals with blunted edges and sometimes pitted faces. The largest of these are about one-quarter of an inch in thickness, while the smallest are less than half a rice grain. Some of them are purplish-gray in color. Very distinct crystalline grains of green pyroxene, nearly a quarter of an inch in diameter, are also visible here and there through the stone. They present one very distinct cleavage like ordinary sahlite. In color they vary from pistachio-green to dark blackish grass-green. Olivine in grains of a light-yellowish green color and nearly transparent is everywhere disseminated through the mass, even through the white patches of chladnite where, however, the color fades to a very pale wine-yellow tint. The minute black pitchy crystals were found to exhibit equilateral triangular faces and to possess under the blowpipe the characteristic reactions of chromite. They are very numerous and occur, along with exceedingly fine grains of nickeliferous iron, in every portion of the mass. The pyrite, though proved

by a treatment of the powdered stone with hydrochloric acid to be present, is nevertheless not to be recognized even with a glass. Among the other constituents of the stone I noticed a single crystal (apparently dodecahedral) of a hard red earthy mineral, closely resembling the substance I called garnet in the Nobleboro (Maine) meteoric stone.

The stone breaks with rather more than the usual facility of meteoric stones. The specific gravity of fragments =3.23. The nickeliferous iron separated by the magnet amounted to 2.5 per cent. The stone was then finely powdered and on digestion with strong hydrochloric acid readily suffered decomposition in the feldspathic part of its constitution with the separation of silicic acid. The solution afforded the following constituents in the ratios annexed:

Alumina	13.00
Lime	4.00
Protoxyd of iron	1.80
Magnesia	.50

which, coupled with the concurring mineralogical and blowpipe evidence of the character of the leading constituent of the stone, leaves no doubt of its being true anorthite. The pyroxene, chladnite, and olivine afforded each the usual blowpipe proofs of their agreement with those species, respectively.

The following may be taken as a tolerably close approximation of the mineral constitution of the Petersburg stone:

Anorthite	82.0
Chladnite	9.0
Olivine	5.0
Pyroxene	1.0
Nickeliferous iron	2.5
Chromite and pyrites	0.5
	100.0

Smith [3] four years later published a very similar account of the meteorite, giving practically no new information.

Rose [4] classed the meteorite with Juvenas, Stannern, and Jonzac as a eukrite and described it as follows:

The eukrite of Petersburg is at first glance a very strange looking eukrite. The mineralogical museum possesses two not very large pieces which were obtained from Shepard by Dr. Bondi. The larger part of the stone consists, so far as these show, of a grayish-white, fine-grained, friable mass which, examined with a lens, is seen to be a fine mixture of small brown and snow-white grains containing single larger greenish-yellow grains of olivine, also small grains of troilite and little flecks of rust which come from the nickel iron, of which one can draw from the powder with a magnet a not inconsiderable quantity for a eukrite. In this general mass lie portions a half inch in diameter of a coarser mixture of brown and white grains which are plainly augite and anorthite and are very similar to those seen in Juvenas and Stannern. Also there are found in the gray mass angular black particles sharply separated from their surroundings and having a flat dull fracture. This can not be recognized with the lens as a mixture but it may be, since before the blowpipe it, like the gray matter, melts on the edges to a black glass which is weakly attracted by the magnet, and which, in salt of phosphorus, leaves a skeleton of silica and a glass colored weakly green by iron. Externally the meteorite has a black shining crust like that of Juvenas and Stannern. The eukrite of Petersburg thus corresponds with other eukrites and differs from them only in the addition of olivine and a somewhat greater quantity of nickel iron.

Reichenbach [5] gave the following description of the occurrence of what he believed to be pure sulphur in the meteorite:

A specimen of the Petersburg meteorite, 2 ounces in weight, exhibited just under the crust a pale yellow inclusion of the size of a transverse section of a lentil. It is of a scaly crystalline structure upon the fracture, pure sulphur-yellow in color, easily friable under the knife, and crushes under the teeth with the peculiarity of sulphur. I was not in a position to push the analysis further but hazard the guess that the sulphur-yellow substance can be nothing else but pure sulphur.

Rammelsberg [6] gives the following analysis of Petersburg: "Augite 68.6 per cent, eukrite (anorthite) 30.0 per cent, magnetic pyrites 0.6 per cent." The composition of these is as follows:

Anorthite (eukrite).

SiO_2	Al_2O_3	CaO	Na_2O	
12.90	11.05	5.28	0.83	= 30.06
42.91	36.76	17.56	2.77	=100

Augite.

SiO_2	FeO	MgO	CaO	
36.31	20.41	8.13	3.73	= 68.58
52.94	29.76	11.86	5.44	=100

Sorby [7] made the following mention of the structure of the meteorite:

Passing from the structure of individual crystals to that of the aggregate we find that in some cases we have a structure in every respect analogous to that of erupted lavas, though even then there are very curious differences in detail. By methods like those adopted by Daubree there ought to be no more difficulty in artificially imitating the structure of such meteorites than in imitating that of our ordinary volcanic rocks. It is, however, doubtful whether meteorites of any considerable size uniformly possess this structure. The best examples I have seen are only fragments inclosed in the general mass of the Petersburg meteorite which, like many others, has exactly the same kind of structure as that of consolidated volcanic tuff or ashes.

Wadsworth [8] classed the meteorite as a basalt. Tschermak [9] continued Rose's classification as a eukrite, but Brezina [10] grouped it as a howardite.

The meteorite is distributed but Wülfing [11] lists only 399 grams, of which Berlin possesses 73 grams and the British Museum 53 grams. Ward [12] possesses 224 grams, in addition probably to that listed by Wülfing.

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PIPE CREEK.

Bandera County, Texas.
Latitude 29° 43′ N., longitude 98° 50′ W.
Stone. Veined crystalline chondrite (Cka); Erxlébénite (type 34) of Meunier.
Found 1887; described 1888.
Weight, 13.5 kgs. (30 lbs).

The first and principal account of this meteorite was by Ledoux [1] as follows:

The meteorite presented herewith was found by a farmer named J. W. Scott in December, 1887, on the lands owned by the firm of F. W. Gross & Co. near Pipe Creek, Bandera County, Texas, 35 miles southwest of San Antonio. It was supposed to be an ore of some kind and was broken up and a piece sent to my firm to be assayed. Unfortunately the specimen was not particularly scrutinized but, like other samples constantly coming in for assay, was handed to a man to pulverize who succeeded in breaking up a large portion of it. The difficulty which he experienced in pulverizing it led to his bringing it to me and to my giving it a more careful examination, when I saw that it was of meteoric origin. After considerable correspondence I have obtained the whole of the specimen. It originally weighed 30 pounds and as described by the farmer who found it its shape was "like a loaf of baker's bread." It is essentially a spheroid, flattened on the side which struck the earth. When it fell it was clearly in a semifluid or pasty condition and flattened out. The locality is prairie land and the finder was attracted by the stone slightly protruding from the hard clay soil quite near a roadway, down which he had often passed without previously observing the meteorite.

There is upon the exterior an oxidized crust, showing the effect of heat and weathering. The interior has a somewhat crystalline appearance to the eye, thickly dotted with pellets or irregularly shaped nodules of soft iron, none of them larger than a quarter of an inch in diameter. Near the surface they are all rounded by the heat action. Examination of the fragments with a microscope, and of a polished surface, shows, in addition to the metallic particles, iron pyrites, occasionally in perfect octahedra, and olivine—both yellow and green varieties—with amorphous silica or silicates. * * *

I have given our fellow member, Mr. George F. Kunz, a portion of the specimen for micro-petrographic study of a thin section. I believe he intends to give you the result of his examination in the fall.

An examination of the fractured mass shows it to be of the ordinary type of stone meteorites. The color is gray and the luster somewhat vitreous. The metallic particles are quite evenly distributed through the mass.

A chemical analysis was made as follows:

The metallic portion, by attrition and with the magnet, was freed from the stony matrix. The mass consisted by weight of: Metallic portion (30.89 per cent), stony portion (69.11 per cent).

The metallic portion contained—

Fe	Ni	
90.94	9.00	=99.94

The stony part contained—

Silica	35.61
Sulphur	3.45
Lime	2.25
Magnesia	15.09
Phosphorus	0.25
Iron (combined) with a little Al_2O_3	12.15
	68.80

While this analysis is not complete, it serves to show the matrix to consist (besides the pyrites) of silicates. The metallic portion is the usual nickel iron combination of which Caille is perhaps the best type. The silicates, besides olivine, seem to have iron as the chief basic constituent.

Brezina [2] classed the meteorite as a veined crystalline chondrite, and remarked concerning it as follows:

Has a coarse interrupted crust not very different from the rest of the dark mass. Shows an emphatically crystalline structure with a fine metallic vein of the form of a folia bent at an obtuse angle.

The meteorite is distributed, with the largest quantity (3,965 grams) in the Ward-Coonley collection.

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PITTSBURGH.

Allegheny County, Pennsylvania.
Here also Millers Run.
Latitude 40° 30′ N., longitude 80° 0′ W.
Iron. Coarsest octahedrite (Ogg), of Brezina.
Found about 1850.
Weight, 132 kgs. (292 lbs), mostly wrought up.

The first mention of this meteorite was by Silliman,[1] as follows:

The second mass of iron noticed by Professor Silliman was found in the State of Pennsylvania, near the city of Pittsburgh. The attention of Professor Silliman was called to this mass by Mr. George Weyman, a student in the analytical laboratory of Yale College, and through him all the details of its history have been obtained which can now be hoped for from Mr. John H. Bailey, of Pittsburgh. Professor Silliman then read extracts from a letter from Mr. Bailey, dated June, 1850, from which it appears that this mass of meteoric iron was found in a field upon Millers Run, in Allegheny County, Pennsylvania, near Pittsburgh. A farmer was ploughing in the field, where, seeing a snake, he seized a stone, as he supposed, to destroy the animal, but, finding it remarkably heavy, he was attracted, after completing his purpose, to examine the body which possessed such remarkable weight. It was carried to Pittsburgh, where it was found to be very malleable, and unfortunately wrought into a bar, which has since been lost sight of. The mass was of an ovoidal figure, almost 6 or 7 inches in diameter, and weighed nearly 292 pounds. It is greatly to be regretted that only a very small portion of this large mass has been preserved. A qualitative examination of it has shown that it is rich in nickel, and possesses only a very inconsiderable portion insoluble in acids. Professor Silliman stated that he would present a complete analysis of the mass when he had received the portion still remaining, which is now on its way from Mr. Bailey.

Shepard [2] gave the specific gravity as 7.380.

Reichenbach [3] included it among the irons with Widmanstätten figures showing a beautiful development of tænite and glanzeisen.

Genth's [4] account of it, as copied in the American Journal of Science from the Report of the Geological Survey of Pennsylvania, was as follows:

A chemical examination of the Pittsburgh meteorite yielded the following results: Its specific gravity, which Shepard gave as 7.380, was found to be 7.741, the average of three closely corresponding determinations by Dr. Koenig, Dr. Headden, and myself. After polishing and etching with dilute nitric acid it presents Widmanstätten figures, which are produced by inclosed schreibersite. In the section which has been made it happens that most of the exceedingly minute schreibersite crystals are cut across and are seen as small dots on a frosted surface; some appear as minute needles, arranged in parallel lines like the trees in an orchard. A few elongated patches of a whiter nickel-iron alloy are also visible.

The analysis of a somewhat oxidized piece gave the following composition:

Fe	Ni	Co	Cu	Mn	S	P	
92.809	4.665	0.395	0.034	0.141	0.037	0.251	=98.332

Brezina,[5] in 1885, classed the meteorite as a hexahedrite with twinning lamellæ, also showing cubic cleavage and Neumann lines. With it he placed Lime Creek, Coahuila, Braunau, etc. He had, however, only a piece of 2 grams for investigation.

Cohen [7] investigated the 99-gram specimen of this iron in the Göttingen University collection. He described it as follows:

It was a very irregular piece with ragged edges, and had evidently been cut with a chisel from the mass and from the peripheral portion of the latter, since there seemed to be small flat parts of the border of the original surface of the meteorite. By cutting, a surface of 4 sq. cm. was obtained.

Etching proved that Millers Run is actually, as Reichenbach stated, an octahedrite. The coarse lamellæ are for the most part of an irregular lumpy form, sometimes also elongated and regularly bounded. Some of the bands lie immediately upon one another, others are divided by a minute cleft; between many of them, however, a distinct tænite band is found, which at the point where several lamellæ cluster together broadens out into somewhat large, triangular portions. That no schreibersite is present is easily proven by testing the ductility with a fine needle. As usual in coarse octahedrites, plessite is very inconspicuous; the tiny little portions are rich in combs.

The kamacite acts differently. At some distance from the original surface of the mass it is coarse-grained, shows distinct hatching marks and numerous uniformly distributed etching pits; the more granular it is the less prominent are the hatchings, while the etching pits remain about the same in amount. In a few bands numerous small, brightly glistening rods are found, which appear to be schreibersite.

An outer zone of from 1 to nearly 1.5 cm. in breadth, whose border runs in a wavy or serrated outline, but which is abruptly cut off and does not coincide with the boundaries of the lamellæ, appears much altered. It is duller and darker than the interior of the meteorite, and the kamacite is spotted, while very irregular particles as much as 0.5 mm. in size are distinctly differentiated from one another by a lively oriented luster, though not sharply separated. The coarse granulation of the bands is obscured or entirely disappears.

This is undoubtedly a zone of alteration; whether it is original or not, or whether the piece under investigation was partially heated in the working up of the main mass and then cut off, must remain uncertain. The latter may be more probable, since in the case of so large a mass (132.5 kg.) a considerably narrower zone of alteration is usually met with, unless, indeed, this should be a tonguelike projection.

The only accessory material observed was a few small particles of schreibersite.

The analysis by Hildebrand gives the following figures:

Fe	Ni	Co	Cu	Mn	Cr	S	P	Chromite	
93.38	5.89	1.24	0.05	0.00	0.02	0.07	0.15	0.07	=100.87

This gives the following mineralogical composition:

Nickel iron	98.78
Schreibersite	0.96
Troilite	0.14
Daubréelite	0.05
Chromite	0.07
	100.00

As stated by Silliman,[1] only a little of the mass has been preserved. Wülfing lists 592 grams, of which the Yale collection possesses 213 grams, and the British Museum 208 grams.

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PLYMOUTH.

Marshall County, Indiana.
Latitude 41° 21′ N., longitude 86° 17′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1893, described 1895.
Weight, uncertain; about 3 kgs. (6 lbs.) known.

This meteorite was first described by Ward,[1] as follows:

The Plymouth meteorite was found in the year 1893 by Mr. John Jefferson Kyser, while plowing in a field on his farm about 5 miles southwest of the town of Plymouth, Marshall County, Indiana. Mr. Kyser had, about the year 1872, found in the same field another larger mass of the same iron. This mass was pear-shaped, about 4 feet in length by 3 feet in its widest diameter, narrowing to 6 or 8 inches at its upper end. It lay for a year or two so near the surface of the ground as to be seriously annoying in plowing the field. On that account Mr. Kyser, aided by his son, dug a deep hole by the side of the mass and buried it to the depth of 1.5 to 2 feet beneath the surface, where it should henceforth do no damage. The account of this I had last June from the son, Mr. John M. Kyser, now city clerk of Plymouth. Mr. Kyser well remembers the circumstance of the finding of the large piece and assisting his father in burying the same; and he further thought that, notwithstanding the removal of certain landmarks (a fence and tree) in the field, he would still be able to locate it very closely. This he subsequently undertook to do by trenching, but was unsuccessful in finding the mass. I was myself present and assisted in a further search for it in September last, using a surveyor's magnetic needle with the hope of the same being attracted to the mass and discovering it, but all to no purpose. Mr. Kyser seems to feel very confident of his knowledge of the immediate vicinity of the mass where he buried it 22 years ago, but is unable to prove its presence by rediscovery. Nor has he the aid of another eyewitness, his father having died soon after the original finding and burying as above mentioned.

The smaller piece, which was, as before said, found in 1883, was presented by Mr. Kyser, sr., to Mr. W. S. Adams, who at that time kept a plow factory in the city of Plymouth. It was retained in their family until last November, when it was brought to Ward's Natural Science Establishment, in Rochester, New York, by Mrs. Adams, from whom I procured it.

The mass is a lengthened tonguelike form, not unlike a rude mound builder's ax. Its greatest length was 12.5 inches; its width 7⅞ inches; its thickness in the middle about 2 inches, from which, in the greater part of its length, it slopes in a somewhat even manner to a thin, rounded edge.

Its surface is deeply eroded by oxidation, so that although sound and free from scales, it shows no signs of an original crust. The characteristic pittings of meteorites are also lessened from the same cause, although they are still quite clearly visible. We have cut quite a number of thin slices from the mass. These etched in dilute nitric acid give very clear Widmannstätten figures. There are further several small nodules of troilite.

Analysis by J. M. Davison gave:

Fe	Ni	Co	Cu	P	Graphite	S	
88.67	8.55	0.66	0.24	1.25	0.11	0.07	=99.55

This iron, herein briefly noticed, is interesting in many ways, and it is much to be regretted that the large mass, of which the record seems to be entirely reliable, can not be rediscovered.

Brezina[2] gave an account of the structure as follows:

Plymouth shows upon a section through the entire iron upon the one long side a flat contour with a weakly defined crust zone and a half-melted nodule of troilite the size of a hazelnut; the opposite long side is of a bent-shield form, marked at the apex with numerous hollows, outwardly even, inwardly ragged, which are filled with bright yellow concentrically marked coatings of iron enamel; on this side there is visible a 2 to 6 mm. thick lustrous zone of alteration. Another piece shows on one of the small, naturally bounded surfaces many fusion hollows of ragged interior filled with bright gray fused crust on a sparkling alteration zone 1 to 5 mm. thick. On the other long side there is a lump of troilite, melted to one-third its proper size, which shows peculiar fine cracks. The lamellæ are 1 to 1.2 mm. thick, puffy, somewhat crumpled; tænite is well developed, the fields are predominant, almost entirely filled with ridges having the aspect of lamellæ; the kamacite is dull and contains numerous isolated crystals of cohenite.

Cohen[3] states that Plymouth shows a more or less strong permanent magnetism and gives the specific gravity as 7.7125.

The Bement Collection is stated to have acquired the principal mass.

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Polk County. See Fisher.

PONCA CREEK.

Holt County, Nebraska.
Here also Dakota and Dacotah.
Latitude 42° 52′ N., longitude 98° 30′ W.
Iron. Coarsest octahedrite (Ogg) of Brezina; Braunite (type 3) of Meunier.
Described 1863.
Weight, 45 kgs. (100 lbs.).

This meteorite was described chiefly by Jackson,[1] as follows:

On the 9th of June, 1863, I received, through Messrs. John W. Shaw & Co. of this city, a mass of meteoric iron from John B. Hoffman, Esq., United States Indian agent for the Ponca Tribe of Indians. This mass of metal was supposed by Mr. Hoffman to be some native alloy of silver and it was sent here to be assayed for that metal.

The mass in my possession weighs 10 pounds 10 ounces, and is 6 inches long, 5 inches wide, and about 2 inches thick, but is of an irregular form, the weathered or exterior surface being much indented or wavy and pitted, while its opposite side is columnar, a natural fissure having existed between it and the large mass from which it was detached by the aid of a sledge hammer. It is stated that this piece was broken from a lump of the same kind which was estimated to weigh 100 pounds.

It was found on the surface of the ground in the Dakota Indian territory, 90 miles from any road or dwelling.

Where it has been rubbed and partially polished the iron has a silvery appearance, and hence the mistake entertained as to its probable nature.

Excepting on the exterior of the columnar portions, which have a steel-like crust, the metal is very soft and saws or files easily. It has a bright surface when cut. No earthy or stony matter has been found in it, and, judging from its great density, it appears to be solid in its interior. Pieces were sawed off in different places and these were polished and tested with dilute nitric acid for the production of Widmannstätten figures, but none have thus far been produced. Only a scaly-like structure, quite fine, is developed by the acid, or when a lump of the iron is dissolved ridges and fine projecting points are left on the undissolved metal. I noticed the singular phenomenon of the indifferent state of the iron to nitric acid while dissolving this metal. After a rapid boiling effervescence with a rush of red fumes of nitric acid the chemical action suddenly ceased and could not be renewed by the addition of more nitric acid nor by a boiling heat, but on inclining the glass beaker so as to cause the metal to come in contact with the other side of the glass tumultuous chemical action instantly commenced and the solution went on rapidly. This seems to show that the electrical state of the metal and of the glass is concerned in the indifferent state of the metal to the acid.

Qualitative examination soon demonstrated the existence of nickel, phosphorus, tin, cobalt, and chromium in this meteorite.

Its specific gravity, taken with much care, was found to be 7.952. Its hardness that of the softest malleable iron, except on the exterior of the columnar portions, which were as hard as case-hardened iron, resisting the saw and causing a sharp cry under the file. No carbon was found.

The quantitative analysis was effected on two separate pieces, sawed from two of the columns, and the proportion of nickel was twice determined, the iron in both cases being removed as a succinate by the well-known processes.

By blowpipe examination, tin in metallic grains was obtained, and the presence of small proportions of cobalt and chrome were proved. Phosphoric acid was found by molybdate of ammonia, and was in the analysis separated in the state of pyrophosphate of magnesia.

Although the analysis is not quite complete, yet it is enough so for our present purpose in demonstrating the meteoric nature of this metallic mass under examination.

The following are the percentage results of my analyses, executed on a gram in each trial:

	1	2
Metallic iron	91.735	91.735
Metallic nickel	6.532	7.080
Tin	0.063	0.063
Phosphorus	0.010	0.010
	98.340	98.888

The cobalt was proved by the blue color the nickel gave with the borax bead; chrome, as shown by the bead of the nickel oxide in microcosmic salt, the green color being persistent in the reducing flame and coming out as the red color produced by the nickel in the hot bead faded. Chlorine was searched for in a solution of 53.7 grains of the meteorite, but none was discovered.

I have requested Mr. Hoffman to procure and send to me the remainder of this interesting meteorite, and also to inquire of the Indians for other specimens and to procure them if possible. Though of no economical value, these specimens from beyond our world are of great interest to science, and if our friends on the Pacific shore will look for them I have no doubt many larger masses of meteoric iron may be found there.

Haidinger [2] recorded the receipt of pieces of the meteorite weighing ¼ *loth* from Jackson, but made no further observations regarding it except to remark:

Its hardness is that of soft malleable iron, except on the exterior of the columnar portions, which are as hard as case-hardened iron, resisting the saw and causing a sharp cry under the file.

Rose [3] remarked concerning the meteorite as follows:

I received from Professor Shepard one of the pieces cut by Doctor Jackson. It is in part bounded on one edge by the natural surface and here shows a thin border of iron oxide. The iron shows etching lines which run over the whole surface as in the iron of Braunau. Likewise the small intergrown rhabdite crystals which characterize this small division of iron meteorites which consist of one individual without subdivision appear here. On crushing cubic cleavages were also observable. Besides the rhabdite, schreibersite in uncommonly large masses occurs, in one place aggregated together.

Meunier [4] classed the meteorite as braunite and stated that this iron gave only disconnected etching figures here and there as if an originally regular figure had been disarranged and broken. Also [6] he said:

The etched surface shows the ordinary characteristics of braunite, inclosing here and there small grains of rhabdite, many of which show distinctly their quadratic sections. There is, besides, a great mass of schreibersite which is not without suggestion of many arvaites. The resemblance with this latter type is further increased by the presence of many fine cracks lined with carbonaceous matter and inclosing in their axes bright minerals, a part of which are readily referable to troilite, the rest to schreibersite. Crystallized carbon may perhaps be found there. A large nodule of troilite is seen not far from the mass of schreibersite.

Brezina classed the meteorite as a hexahedrite in both the 1885 [5] and 1895 [7] catalogues.

Farrington [8] proposed the name Ponca Creek for the meteorite, as follows:

The writer proposes the name of Ponca Creek for the meteorite usually known as Dakota. The reasons for the change are as follows: The original account by Jackson states that the fragment which he described was given him by the United States Indian agent for the Ponca Tribe of Indians, and further that the mass was found on the surface of the ground "in the Dakota Indian territory, 90 miles from any road or dwelling." In the repetition of this statement by foreign authorities a comma came to be inserted after Dakota, so that the locality was known as Dakota, Indian Territory. There is no such locality, however, and Indian Territory is several hundred miles removed from the place where the meteorite was found. Moreover, the original territory of Dakota, within which the meteorite may have been found, is now subdivided into North and South Dakota, and neither name would designate the locality in a sufficiently limited way. The reservation of the Ponca Indians, who were a tribe of the Dakotas and from whose agent the meteorite was obtained by Jackson, was at that time located along Ponca Creek in Nebraska. It seems reasonable to suppose that the meteroite was found in the vicinity of this creek, and the name Ponca Creek has the additional advantage of containing that of the tribe by some member of which the meteorite was probably originally found. For the meaningless name Dakota, therefore, that of Ponca Creek may well, in the opinion of the writer, be substituted.

The meteorite is somewhat distributed, but only in small quantities. The whereabouts of the main mass is unknown.

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Poplar Camp. See Poplar Hill.

POPLAR HILL.

Giles County, Virginia.
Here also Cranberry Plains and Poplar Camp.
Latitude 37° 13′ N., longitude 80° 47′ W.
Iron. Fine octahedrite (Of), of Brezina; Lockportite (type 16), of Meunier.
Found 1852.
Weight. Only 89 grams are known.

Little or nothing seems to be known of the history of this meteorite. It was first listed by Meunier [1] under the name of Poplar Camp. Brezina [2] lists it as Cranberry Plains, a name which has been generally used since, but as Poplar Hill is a post office in Virginia this name would seem preferable.

Huntington [3] remarked concerning the structure as follows:

This iron shows a very perfect octahedral structure. The lines on the faces of some of these octahedrons illustrate a phenomenon of frequent occurrence, namely, curved plates intermixed with perfect regular and parallel plates. These curved plates must have originally formed through the liquid mass as true planes, like their neighbors, and have been bent in the subsequent solidifying of the remaining material. Otherwise, if they had been distorted by an exterior force, the regularity of the octahedron would have been at the same time destroyed.

Huntington shows these figures in a cut.

Meunier,[4] in 1893, grouped the meteorite as Lockportite, the characteristics of which are "Mixture of kamacite predominating in finely hatched bands and of plesite. Structure octahedral." With this meteorite he groups Cambria, Prambanan, and Losttowa. From Huntington's and Meunier's descriptions and figures, Cohen [6] drew the conclusion that the meteorite should be regarded as a fine octahedrite and placed it with the Prambanan group.

Little of the meteorite is preserved. Wülfing [5] lists 89 grams, of which Harvard possesses the largest quantity (36 grams).

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PORT ORFORD.

Curry County, Oregon.
Latitude 42° 46′ N., longitude 124° 28′ W.
Pallasite (P).
Found 1859; described 1860.
Weight, estimated at 10,000 kgs. (22,000 lbs.).

Little is known of this meteorite. The first accounts of it were given by Jackson,[1] but they are very meager. They are to be found in the Proceedings of the Boston Society of Natural History, and are as follows:

Jackson reported to the Boston Society of Natural History, October 5, 1859, that—

among some specimens recently received from Oregon Territory was a piece of a meteorite containing crystals of olivine, yielding 9 per cent of nickel. It was identical in appearance, and probably in composition, with the Pallas meteorite of Siberia; he thought it not improbable that pieces may have fallen in the same meteoric shower in both countries, as has happened in other instances though less widely separated.

At the meeting of November 2, 1859, he—

read a letter from Doctor Evans, of Oregon Territory, confirming his opinion that the meteorite recently found in that Territory is identical with the Pallas meteorite of Siberia.

November 16, 1859, he—

read some letters from Doctor Evans concerning the meteorite discovered by him in Oregon Territory: the mass, about 3 feet of which was above ground, was in the mountains, about 40 miles from Port Orford, on the Pacific, and easily accessible by mules. He hoped the society, as a body or individually, would take speedy and proper measures to secure its deposition by the Government in the Smithsonian Institution.

April 18, 1860, he—

read letters from Doctor Evans and Professor Henry, of Washington, in relation to the great Oregon meteorite; though individuals of the society had written on the subject, it was feared that from want of a memorial from the society the appropriation necessary to obtain it would not be inserted in the congressional bill.

On motion, it was voted that a committee be appointed with full powers, to see what can be done in the matter, and to take any steps which may seem likely to secure the whole or a portion of this valuable specimen for the museum at Washington. The president appointed Drs. C. T. Jackson, Bacon, and Shaw, to whom the president was afterwards added.

May 2, 1860—

Dr. C. T. Jackson announced that a memorial had been sent to Congress by the committee appointed at the last meeting in relation to the Oregon meteorite, praying that it might, in whole or in part, be placed in the Smithsonian Institution, and be thence distributed to scientific bodies.

Haidinger [2] stated to the Vienna Academy in 1860 that he had received information from N. Holmes of a great meteoric iron mass found by Dr. John Evans on his latest expedition in the southwestern part of Oregon. He stated that it was partly embedded in the earth and was larger than the Siberian Pallas iron. He says:

It lies in the Rogue River Mountains, not very far from Port Orford, on the Pacific, about in 42° 35′ north latitude and 123° to 124° west longitude.

In 1861 [3] he gave a further account of it as follows:

Of the iron mass from Oregon, mentioned in the session of July 5 of last year, news of which was obtained from a letter from Mr. Nathaniel Holmes, of St. Louis, I have the honor to place in the Imperial Mineral Cabinet a piece weighing 3.530 grams, which I owe to the friendly offices of Dr. Charles T. Jackson, of New York City. His analysis was published in the Mining Magazine of New York City for February, 1860, in the Proceedings of the Boston Society, the American Academy of Natural Sciences, and elsewhere.

Dr. John Evans, Government geologist for the territories of Oregon and Washington, discovered the mass 4 or 5 feet in horizonal dimension and exposed 3 or 4 feet high in the Rogue River Mountains, about 40 miles from Port Orford He separated little pieces, of which Doctor Jackson received about an ounce. Unfortunately Doctor Evans died on April 13 (1860), and search for the mass is thus rendered very difficult if its occurrence is not even placed in question. It was hoped that efforts would be made to place this great mass, of which over 200 ctr. are visible, in the Smithsonian Institution in Washington, but the latest reports do not indicate that anything is being done in this direction.

The meteorite belongs, as Jackson has already stated, in the class of Pallas irons, since it has a compact groundmass and large included olivine crystals. Etching produces, not the straight Widmannstätten figures, but figures like those of the Pallas iron, Brahin, and others. The fragment shows yet some of the fine original fusion crust, so that the mass, although exposed, has not been oxidized since its arrival on the earth.

Some further details regarding the location of the meteorite were given by Jackson [4] in a biographical sketch of Doctor Evans. They are as follows:

One of the most interesting scientific discoveries made by Doctor Evans during his explorations in Oregon was that of an enormous mass of meteoric iron containing an abundance of chrysolite or olivine embedded in it. During the Indian war in that region Doctor Evans ascended Bald Mountain, one of the Rogue River Range, which is situated from 35 to 40 miles from Port Orford, a village and port of entry on the Pacific coast, and obtained some pieces of metallic iron which he broke off from a mass projecting from the grass-covered soil on the slope of the mountain. He was not aware of its meteoric nature until the chemical analysis was made, but the singularity of its appearance caused him to observe very closely its situation, so that when his attention was called to the subject he readily remembered the position, form, appearance, and magnitude of the mass, and manifested the most lively interest in procuring it for the Government collection in the Smithsonian Institution at Washington, a duty I doubt not he would have been commissioned to perform had his life been spared.

By the aid of information contained in letters to me perhaps some traveler in those regions may be able to find this very interesting meteorite, and I shall, therefore, transcribe what he says of it. In reply to my inquiry, whether he felt confident he could again find this mass of meteoric iron, he says in his letter of May 1, 1860:

"There can not be the least difficulty in my finding the meteorite. The western face of Bald Mountain, where it is situated, is, as its name indicates, bare of timber, a grassy slope, without prejecting rocks in the immediate vicinity of the meteorite. The mountain is a prominent landmark, seen for a long distance on the ocean, as it is higher than any of the surrounding mountains. It would doubtless be best and most economical to make a preliminary visit to the locality, accompanied only by the two voyagers alluded to in my last letter." (Two of the Canadian Frenchmen in employ of the Hudson Bay Company.)

"Arrangements might then be made with the Indians for its purchase and the best plan selected for its removal. It would be expedient to procure the men and animals necessary in the Umpqua Valley, east of the Coast Range of moun-

tains, as Port Orford at present is quite a small settlement although a 'port of entry.' The meteorite might be shipped in the California steamer to San Francisco and from that port in a sailing vessel round the Horn to Boston."

* * * * * * * * *

In another letter Doctor Evans says: "As to the dimensions of the meteorite I can not speak with certainty, as no measurements were made at the time. But my recollection is that 4 or 5 feet projected from the surface of the mountain, that it was about the same number of feet in width and perhaps 3 or 4 feet in thickness; but it is no doubt deeply buried in the earth, as the country is very mountainous, generally heavily timbered, and subject to washings from rains and melting of snow in the spring, so that in a few years these causes might cover up a large portion of it. The mass exposed was quite irregular in shape."

Buchner[5] stated that Evans estimated the weight of the portion above ground at 10,000 kgs., also states that Jackson found by analysis:

Fe	Ni	Sn and some SiO_2	
89	10.29	0.729	=100.019

Buchner's authority for these statements does not appear in the references which he quotes, which are those of Jackson and Haidinger already given.

Brezina[6] in 1885 grouped it as a pallasite and described it as follows:

It shows enveloping kamacite bands small (0.5 mm.), slightly puffy, and fields 3 to 10 mm. in size with a few bands near the border measuring 0.2 to 0.3 mm., the balance having a fine luster. The Vienna specimen also possesses a fusion crust.

A photograph of the Vienna specimen is given by Brezina and Cohen[7] and the following description:

It shows the swathing kamacite small (0.5 mm.), against the field less swollen than against the olivine. The field is exceptionally large in comparison to the breadth of the swathing kamacite, is generally filled with shimmering plessite, and contains, near the edge, some small bands 0.2 mm. wide, which originate from the swathing kamacite or in one place seem to lie free in the plessite. In the photograph a tongue of troilite with kamacite border projects into the field. Here and in the upper half of the swathing kamacite some small, elongated schreibersite may also be recognized. Tænite is weak. As far as can be determined from so small a piece Port Orford corresponds with no other pallasite.

In 1895 Brezina[8] remarked:

It is somewhat different from Krasnojarsk and Arizona, the enveloping kamacite being less puffy, thinner, more angular, and more easily etched, so that it does not appear so different from plessite and does not remain blank.

Only 4 grams of the meteorite are known to be preserved. This is in the Vienna collection.

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Port Tobacco. See Nanjemoy.

PRAIRIE DOG CREEK.

Decatur County, Kansas.
Latitude 39° 35′ N., longitude 100° 20′ W.
Stone. Crystalline spherical chondrite (Cck) of Brezina.
Known since 1893; described 1895.
Weight, 2.9 kgs. (7 lbs.).

The first description of this meteorite was by Weinschenk,[1] as follows:

This meteorite was discovered upon a farm belonging to N. E. Miller, north of the north branch of Prairie Dog Creek, Decatur County, Kansas. It was found for the most part buried in the soil. I examined several small fragments. These were somewhat weathered and had a rough thick crust of a brownish-gray color.

The composition of this stone is very different from that of Long Island. Chondri were especially numerous even macroscopically, so that a place in the spherical chondrites is required. The color, so far as can be determined from the small rusty pieces afforded for examination, is unusually dark and the stone very compact and hard. Under the microscope, the richness in forms of the chondri which form most of the stone is noticeable. Between these the groundmass appears to be opaque on account of the deposit of iron rust; and even after treatment with nitric acid to remove the rust, no glimpse can be had into the structure, since it is for the most part broken up by the treatment. After etching, only grains and small crystals of pyroxene, as well as of a black opaque material, apparently chromite, remain.

The composition of the chondri is more easily studied than that of the groundmass. Besides chondri were noted several large well-formed crystals of olivine containing large inclusions of dark glass. The mineral content of the chondri shows chrysolite, bronzite, augite, iron, magnetic pyrites, and chromite, besides infrequent grains of plagioclase. Small fragments of silicates and large grains of iron, magnetic pyrites, and chromite are scattered between the chondri. The size of the chondri varies from the tiniest up to 2 mm. in diameter, their form being usually perfectly round, judging from the numerous roundish imprints.

Well-formed crystals of separate minerals occur occasionally in the chondri, but much more abundant are skeleton forms, indicating rapid crystallization. The chrysolite especially occurs in imperfect forms having great similarity with certain artificial enamels, and a glassy substance often very rich in inclusions and injections. Individual chondri consist usually of an undivided crystal mostly of a very imperfect growth. Small nickel-iron chondri also appear. Most of the chondri are porphyritic. They contain, for the most part, large olivine skeletons, besides bronzite and augite, the latter often with twin laminæ. Besides these crystalline constituents glass is almost always present, usually forming a strongly receding base; frequently, however, it occurs also in larger masses; in the latter case it contains skeleton crystals or is rich in crystalline formations. Spherical glass globules are not infrequent. The spherical chondri are usually unitary and imperfectly formed, or they consist of aggregates of spherulites. The latter are at times so finely radiated that they become almost opaque and disguise their mineral composition; they pass over, however, into tolerably coarse-rayed aggregates of bronzite. Many chondri are shattered and with unusual frequency show roundish impressions due to several chondri touching one another in the stages of their formation.

In some cases several chondri are melted together, and in one case a small chondrule had lodged upon a larger one and was partly melted over the surface of the latter.

Brezina [2] gave the following observations upon the meteorite.

Like most crystalline spherical chondri, Prairie Dog Creek is a very peculiar stone. A longish fragment, about the fourth part of a single stone, has a broad side which belongs to the front face and possesses distinctly marked, regular lines of flow; one long and one short side of small dimensions are covered with a side crust which encroaches over from the front; the interior shows a high degree of rusting without any loosening of the very firm, half crystalline structure; here and there broken chondri are visible, in addition to entire ones, the former attaining the diameter of 3 mm. and are sometimes complete individuals. On one place, which has a loose, limonitish appearance, numerous entire, smooth, round chondri of as much as 1.2 mm. diameter may be seen.

Wülfing [3] states the stone in Kunz's possession weighed 2.9 kgs.

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PRICETOWN.

Highland County, Ohio.
Latitude 33° 11′ N., longitude 83° 44′ W.
Stone. White chondrite (Cw) of Brezina.
Fell February 13, 1893.
Weight, about 900 grams (2 lbs.).

No data regarding this meteorite seem to have been published. Apparently a single stone came into the possession of Bement or Kunz, the larger part of which (700 grams) is now in the American Museum of Natural History.

Brezina [1] and Wülfing [2] mention a Pricetown iron which is undoubtedly an imperfect reference to the above stone. In Ward's [3] Catalogue the classification is given as white chondrite and the date of fall as above.

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PUTNAM COUNTY.

Putnam County, Georgia.
Latitude 33° 18′ N., longitude 83° 35′ W.
Iron. Fine octahedrite (Of) of Brezina; Dicksonite (type 12) of Meunier.
Found 1839; described 1854.
Weight, 32.5 kgs. (72 lbs.).

This meteorite was first described by Willet,[1] as follows:

This interesting meteoric iron, the first that has been found in Georgia, was presented to Mercer University by John A. Cogburn in the fall of 1852.

The circumstances of its discovery, as detailed by Mr. Cogburn, are briefly these: The iron was first observed by his overseer in 1839 in a field which had been cultivated for several years, but was supposed to be the common black rock of that region. Mr. Cogburn first noticed it in March, 1840, and attempting to raise it from the ground, found it so heavy that he carried it to his blacksmith shop to have it broken. Its weight at that time was 72 pounds, and the mass was coated deeply with a brown scaly crust. He attempted to break it upon an anvil, but could remove only the outside crust, including a large blister, the place of which is now indicated by a deep fissure. Finding it so untractable, he threw it into his yard, where it lay neglected until a knowledge of the fact led me to request him to send it to the University for examination. He states further that he supposes it to have been originally buried and brought to the surface of the earth by cultivation and the action of rains; that there is no tradition of its fall; and that no similar pieces have been found in the neighborhood.

Its weight, when it was brought to the University, was about 60 pounds. In shape it represents a rude triangular pyramid, with its base and edges rounded, and its faces exposing many knobs and depressions.

Most of the crust has been removed by the rough handling which it has received. The outer layers of what remains separate in thin scales of no regular shape; the inner portions break into rhombohedral masses, which, under the influence of a magnet, become permanently magnetic, showing that the iron has been converted into magnetic oxide. The mass of iron exhibits no magnetism.

In removing a slab, the iron was found to be remarkably tough and compact. The torn edges oxidized rapidly and developed the crystalline structure before the application of acid; the oxidation proceeded inwardly from the edges, following the lines of cleavage first, and afterwards spreading over the inclosed areas. The sawn surfaces, after a few days exposure, were found bedewed with drops of a liquid, supposed to be chloride of iron. After longer exposure the exudation ceased—a point of striking similarity with the Texas iron. The polished surface is uniform, without markings, and with few flaws.

Hydrochloric acid applied to the heated slab attacks it with a rapid evolution of hydrogen bubbles, but develops only a few of the larger bars, and the crystalline structure of the mass might be overlooked with the action of this acid alone. Nitric acid, however, brings out the Widmannstätten figures most beautifully. The etched surface is a perfect miniature copy of the Texan iron; the largest bars of the Putnam County iron corresponding with those of medium size in the Texas iron, and thence diminishing to bundles of striæ hardly visible to the naked eye. The triangles and parallelograms are proportionally small. Query: Are the crystalline figures of meteoric irons in any degree proportional to the meteoric masses? If so, may we not infer from the size of them whether the iron be an entire mass or a fragment of a large one?

Neutral sulphate of copper produces no precipitate of metal on the iron, the slightest addition of acid causes the deposit of copper. Moreover, I find that if the film of copper be wiped off as soon as formed, the sulphuric acid has etched out the figures superficially but very imperfectly. Liquid sulphuric acid when cold has no effect upon the surface.

In addition to the above description, I subjoin an interesting note from Professor Shepard, containing an analysis of the iron, which he has very kindly furnished at my request.

"In comparing the Putnam County meteoric iron with specimens from other localities, I notice a striking similarity in its structure to that of the Texan mass. Like it, your iron is compact, nearly free from pyrites, and but slightly disposed to rust on exposure to the air. But the resemblance between the two is seen to the greatest advantage, when etched samples are compared with one another. The Putnam County iron exhibits figures of the same shape and size as the Texas, viz, triangles and oblique-angled parallelograms bounded by slightly-raised edges which are often wavy, and sometimes not continuously of the same thickness, but here and there bulging out into beads or knobs. The pyrites in my specimens is scarcely to be recognized, except in one or two very limited patches which are irregular and veinlike.

"The iron appears to have suffered a very remarkable disintegration to the depth of half an inch or more below the thick, scaly crust with which the mass was coated, in consequence of which it cleaves very regularly like the Cocke County, Tennessee, iron into tetrahedral and rhomboidal fragments.

"The specific gravity of the fresh internal portions of the mass is 7.69. A single analysis gave me the following result:

Iron	89.52
Nickel, with traces of cobalt	8.82
Tin, phosphorus, sulphur, magnesium, and calcium	1.66
	100.00

Reichenbach [2] emphasized the fineness and regularity of the Widmannstätten figures, saying: "Putnam appears as fine as the grain of pear wood on the side of the mirror." He mentions also pale-blue plessite, infrequent combs, absence of swollen kamacite, bronze-colored iron sulphide, and iron glass.

Rose [3] called attention to the regularity, fineness, and beauty of the figures and noted the presence of troilite mixed with nickel iron.

Brezina [5] gave the following observations:

Putnam is especially rich in combs which are definitely distinguished from the system of bands. The troilite frequently has daubréelite bands parallel to one another. The troilite is crystallized in hexagonal pyramids and the daubréelite laminæ lie parallel to their bases, as I first observed them in Coahuila.

Huntington [6] gave a figure of an etched octahedron broken out from the Putnam County meteorite. He states:

This iron appears, by oxidation of the surface, to break up into octahedrons and acute rhombic prisms. The octahedron represented in the figure was so loose in its structure that it was necessary first to mount it in pitch before grinding the face in order to prevent the plates from splitting off. Here the character is much the same as in De Kalb except that the plates are smaller and at points the iron is perfectly granular, showing no signs of crystallization. Moreover, the groundmass, instead of containing the combs above mentioned, has been broken up by a series of irregular cracks into coarse grains very much like a mass of crackled glass.

Meunier [7] note the following:

This iron is entirely analogous to that of Charlotte, with still more abundant plessite. The tænite frequently forms needles broken in two parts which meet at an octahedral angle.

A specimen in the Paris Museum shows a figure very strongly etched upon which are very distinctly visible several somewhat irregular laminæ of schreibersite. Outside of this figure appear grains of pyrrhotine showing crystalline markings and several laminæ of daubréelite.

Brezina [8] in 1895 remarked that Putnam resembled Bückeberg, but showed somewhat less puffy kamacite.

Cohen [10] gave the following observations:

The lamellæ are long, straight, isolated or crowded together, sometimes granular and not puffy. The tænite seams are very distinct, fields well represented and quite prominent. Brezina states that the kamacite is hatched, but I have on two sections of very different crystallographic orientation and under various degrees of etching observed no trace of hatching. On the contrary there has been an exceptionally uniform fine-grained structure (grains scarcely 0.003 mm. in size). In consequence of this the luster in reflected light is merely dull. A small portion of the fields, including a few of the larger as well as the smaller, consist of dense, very dark plessite which under a high magnifying power reveals a few tiny uniformly distributed spangles. The predominant fields are brighter and are composed of grains measuring at most 0.15 mm. in size, irregular in form, reflecting simultaneously, and sharply defined from one another. They contain roundish tænite disks as much as 0.02 mm. in size quite uniformly embedded throughout the parent grains. These grains, which are sometimes roundish, sometimes walnut-shaped, and again quite irregular in form, show again in their turn a fine-grained structure and resemble exactly the kamacite of the bands. There is no repetition of the structure on a large scale, however, since no trace of tænite border bands and small fields crowded between was observed. The fine dark veins which apparently divide the grains consist of slightly-etched grooves. A field is sometimes found which is composed of complete lamellæ and a little dense plessite compacted between them. The latter are considerably more soluble in acid than the granular portions and accordingly the fields filled with it after strong etching appear considerably deepened.

Schreibersite appears to be sparingly present in macroscopic particles. It was only observed in a few small grains; in the neighborhood of the natural surface some magnetite is present.

Analysis by R. Knauer and O. Berger:

Fe	Ni	Co	Cu	Cr	S	P	
90.28	7.89	0.79	0.07	0.17	0.25	0.11	=99.56

Composition:

Nickel iron	98.69
Schreibersite	0.72
Daubréelite	0.47
Troilite	0.11
	100.00

Putnam takes on strong permanent magnetism;[9] the specific magnetism was determined by Leick at 2.40 absolute units per gram.

The principal mass of the meteorite (30 pounds) is in the Amherst collection. In addition Wülfing lists about 4 kgs., of which the Harvard collection has about one-half.

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Ranchito. See Bacubirito.

RANCHO DE LA PILA.

Durango, Mexico.
Here also Durango of Partsch and Pila.
Latitude 24° 2′ N., longitude 104° 36′ W.
Iron. Medium octahedrite (Om), of Brezina.
Found 1882.
Weight, 46.5 kgs. (102.3 lbs.).

The first account of the meteorite known to be from this locality was given by Hapke,[3] as follows:

In the spring of 1882 an iron was found by plowing in a field belonging to Rafael Brancho at Rancho de la Pila, 9 leagues east of Durango. The soil of this field contains considerable limestone. According to the view of the finder and owner, the mass must have fallen since the last plowing of the field the year before, since, as it was only 25 or 30 centimeters deep, it could hardly have been overlooked in plowing.

Hilmer Wilmanns, a merchant of Durango, with whom, when in Durango in 1877, I had talked regarding Mexican meteorites, obtained a piece of this iron and sent it to his associate, Julius Hildebrand. The latter in 1882 sent me five pieces of this iron, which together weighed 15½ grams and showed a well-marked crystalline structure. These pieces were strongly magnetic, so that they were not only attracted by the magnet but themselves attracted iron filings. The largest piece weighed 4 grams, which, like the others, had a dark crust, showed on cutting a hardness almost like that of steel and a tin-white color, Since, also, on etching with moderately dilute nitric acid very beautiful Widmanstätten figures were produced, the meteoric nature of the substance was considered certain. Herr Hildebrand accordingly had sent on the whole mass, which arrived in Bremen in April. The meteorite was brought to the session of the academy of April, 1883, and compared with examples of other meteorites in the museum. By the efforts of Dr. W. O. Ficke, a cast of the original was made for the mineralogical division of the museum. A second was made for the mining school here and another for the Vienna Museum.

The mass is of a prismatic-pyramidal shape, weighs 46.4 kilos, has a length of 30 centimeters, a breadth of 23½ centimeters, and a height of 18 centimeters. A dark gray or brown shining crust envelops the mass except where pieces have been broken off. The crust is shown by a stroke of the file to be very thin, supporting the view of the finders that the iron had not lain very long in the earth. A file stroke shows further a tin-white color and a homogeneous mass. The mass is penetrated by four parallel clefts which indicate that the foliated crystalline structure extends into the interior. The surface of the mass shows many depressions in which, here and there, occur fine striæ. On one side there is a round depression 1½ centimeters deep and 2 or 3 centimeters wide. On the opposite side there are two of these, one large and one small, not so irregular as the first. The octahedral structure and the parallel foliated appearance are well shown without etching and more strongly by etching. The foliated or banded structure characterized by equilateral triangles and parallelograms shows fine parallel striations and hackly fracture, with single small crystals projecting. On placing a polished and etched surface for a second time in a more concentrated acid the luster became duller, and under the lens there could be distinguished parallel striæ and granular portions. The crust in other places was likewise dissolved by nitric acid. Here, also, the iron showed a tin-white color and granular portions which distinguished themselves from the more deeply attacked portions. The specific gravity of a piece weighing 4.25 grams, almost without crust, was found to be 7.89, while that of a flat piece, almost entirely covered with crust, was found to be 7.74. Dr. Janke obtained the following composition by analysis:

Fe	Ni	Co	P and C	
91.78	8.35	0.01	traces	=100.14

The large mass was purchased by the British Museum.

Brezina,[4] under the name of Rancho de la Pila 1804, grouped the meteorite among the Caille division of the medium octahedrites and described it as follows:

It is free from troilite, the specks of kamacite are quite fine, and the bands 0.8 mm. wide. The more definite indication of the locality of discovery is taken from a newly discovered piece procured from the British Museum. Like the older ones, it shows distinctly the weathering out of octahedral skeletons.

Fletcher[5] connected with the Rancho de la Pila mass one mentioned by Partsch[1] in 1843, obtained from Karawinsky. His reasons for combining these are given as follows:

A fragment of meteoric iron was acquired in 1834 from Freiherr von Karawinsky for the Vienna collection; he had brought it with him from Mexico, and according to his statement to Partsch, it had been severed from a mass which weighed several hundred pounds and lay in the plain northeast of Durango. There is no statement that Karawinsky had himself seen the original mass; nor does he mention the distance from Durango city.

We have already seen that Weidner, when discussing the Mercado, remarked in 1858 that the fragments given to Humboldt as Durango iron might very well have been brought from Durango and at the same time have been either got from the "Labor de Guadalupe, an estate near Durango city," or from one of the two big masses which were lying at "Concepcion and Rio Florida."

We infer that in 1858 it was regarded by Weidner as a recognized fact that metallic iron, not comparable in size with the Chihuahua masses, had been really found at the Labor de Guadalupe; a search for a definite statement of the discovery of metallic iron on that estate has been unsuccessful.

But I am informed by Dr. Carlos Santa Maria, of Durango, that the above extensive estate begins at 5 leagues northeast of the city; and this is the very direction which was assigned by Karawinsky for the locality of the mass of which he sent fragments to Vienna in 1834; hence it is extremely probable that the Karawinsky mass is the one which Weidner had in mind, when in 1858 he referred to the iron of the Labor de Guadalupe. No other record of the discovery of a Durango mass on the eastern side of the city before 1858 can be found.

A mass weighing 46.4 kgs. was turned up by a plow in 1882 at the rancho of La Pila, 9 leagues east of Durango. Dr. Carlos Santa Maria sends me the information that the rancho is part of the estate called La Labor de Guadalupe, which begins 5 leagues northeast of Durango and extends as far as La Pila, close to the hacienda of La Punta shown in Garcia Cubas' map as 10 leagues southeast of Durango. * * *

The specimen is now in the British Museum collection.

Confirmation of the above suggestion as to the site of the Karawinsky mass is found in the statement of Brezina, that the etching figures of the mass were identical with those of the one plowed up at La Pila.

Meunier[6] grouped the meteorite as Caillite, giving it the name of Rancho de la Pila, 1804. He described it as follows:

The specimens in the Paris museum from this fall are labeled, some Durango, others Cacaria, but they are identical in every respect. They come from a locality called Rancho de la Pila. Etching gives an entirely normal figure, in which the kamacite forms elongated bands, slightly bent. The tænite occurs in very slender filaments and the plessite includes well marked ridges.

Brezina,[7] in 1895, remarked further concerning the meteorite as follows:

Pila has the greatest similarity with Descubridora and should in fact be identified with the latter except for the fact that the localities are separated by 4 degrees of longitude. To Pila belong the pieces which were procured for the Vienna Museum in 1834 by Karawinsky and which, according to Fletcher, came from the small estate of Labor de Guadalupe, which begins 5 leagues northeast of the state of Durango. This same one was known already in 1804, when Humboldt visited the country. Here also belongs a mass of 46.4 kgs. weight which was plowed up on the Rancho de la Pila in 1882 and came into the possession of the British Museum. This iron agrees perfectly with the old Durango iron, the fields in both being entirely filled with spotted combs. Both the old and the new Durango iron show very markedly the weathering out of the octahedral laminæ. To Pila also doubtless belongs the piece indicated as Toluca which was brought by Humboldt to Bergmann, at Berlin.

The meteorite is chiefly (46,512 grams) preserved in the British Museum.

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RANCHO DE LA PRESA.

District of Zenapecuaro, State of Michoacan, Mexico.
Stone. Spherical chondrite (Cc), of Brezina.
Found 1899.

The only mention of this meteorite known to the present writer is that in Ward's[1] catalogue, where the locality given above is recorded and the statement made that the meteorite is a stone. The year 1899 is given as that of the fall or find.

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RED RIVER.

Texas.
Latitude 32° 7′ N., longitude 95° 10′ W.
Here also Cross Timbers, Gibbs meteorite, Louisiana, and Texas.
Iron. Medium octahedrite (Om) of Brezina. Caillite (type 18), of Meunier.
Made known 1818.
Weight, 740 kgs. (1,635 lbs.).

The first mention of this meteorite was in Bruce's Mineralogical Journal,[1] as follows:

There is at present in this city a mass of iron, which was sent hither a short time since from New Orleans by Mr. G. Johnson, and which from its size and weight has excited considerable attention. Its form is irregular. Its length is 3 feet 4 inches, and its greatest width 2 feet 4.5 inches. It weighs upward of 3,000 pounds. Its surface, which is covered by a blackish crust, is greatly indented, from which it would appear that this mass had been in a soft state. On removing the crust, the iron on exposure to moisture soon becomes oxidated. Specific gravity, 7.400.

It appears to consist entirely of iron which possesses a high degree of malleability, experiments having been made without detecting nickel or any other metal. This enormous mass of iron is said to have been found near the Red River. We regret that we are unable to say much as to its geognostic situation or origin, whether native, meteoric, or artificial. We hope, however, from the inquiries we have instituted, to have it in our power shortly to lay before our readers some satisfactory information respecting this interesting object.

In 1824 there was published in the American Journal of Science, under the initials C. H., an account of the meteorite, which included Doctor Bruce's account and "additional facts and remarks drawn from the following sources": 1. A letter from Judge Johnson, of the Supreme Court of the United States; 2. A letter from Mr. William Darby, the well-known geographer; 3. A letter from Doctor Sibley, Indian agent at Natchitoches; 4. The manuscript journal of John Maley, an erratic adventurer; and 5. The manuscript journal of Captain Glass and company.

The account states that the iron had become the property of Colonel Gibbs and had been deposited in the collection of the New York Historical Society, and continues as follows:

In the year 1808, while Capt. Anthony Glass was trading among the Pawnee and Hietan Nations, he was informed concerning a curious mineral which had been discovered on the territory of the Hietans by one of the Pawnees. The mineral could not have been discovered long antecedent to that time, as Captain Glass saw the Indian who claimed the honor of its discovery. Captain Glass and several of his party went, in company with some Hietans and Pawnees, and saw the mass in situ. He does not mention whether the natives entertained any particular opinions respecting its origin; they, however, regarded it with much veneration, and ascribed to it singular powers in the cure of diseases. They informed him that they knew of two other smaller pieces, the one about 30 and the other about 50 miles distant.

This intelligence, announced on the return of Captain Glass, excited no little curiosity; and confident hopes prevailed that the mineral would prove to be platina, or something else of much value.

In 1810, two rival parties were made up for the purpose of obtaining this metal—one at Natchitoches, consisting of George Schamp, who had been with Captain Glass, and nine associates; the other at Nacogdoches, consisting of John Davis, who also had been with Captain Glass, and eight or ten associates.

The Nacogdoches party first arrived at the place of destination; but, having in their hurry to anticipate the rival party, made no preparations for carrying away the metal, they hid it under a flat stone and went away to procure wheels and draft horses.

The Natchitoches party arrived a few days afterwards, and after searching several days succeeded in finding their object. Being provided with tools, they made a truck wagon, to which they harnessed six horses, and set off with their prize toward the Red River. They crossed the Brassos without much difficulty; but a straggling party of Indians having one night stolen all their horses, they were detained until two of their party could go to Natchitoches for more horses. On arriving at the Red River, some of their party went down in a boat with the iron, while others took the horses down by land. From Natchitoches the metal was taken down the Red River and Mississippi to New Orleans, whence it was shipped to New York.

In February, 1812, John Maley, a man who with a roving disposition appears to have possessed a strong and inquiring though uncultivated mind, went with a few associates up the Red River, with a view to explore the country, trade with the Indians, and (if practicable) to bring away the two remaining masses of metal. He saw one or both of the masses; but being unable to make the remuneration for them demanded by the Indians, he continued his tour farther west. Returning he contracted to barter for the pieces of metal a certain quantity of merchandise, to procure which he returned to Natchitoches and proceeded to New Orleans.

On his second expedition up the Red River, in 1813, he and his associates, being robbed by a party of Osages of their merchandise and horses, were compelled to return on foot, relinquishing their object.

Undoubtedly, therefore, two masses at least of this metal still remain in that region, and will probably at some future time enrich some cabinet of natural history. Their precise situation is not so well known as could be wished. The following hints are subjoined, as they may afford some aid to any who may hereafter explore these regions:

Some hundred miles above Natchitoches, on the banks of the Red River, is a Pawnee village; southwest of which, about 50 or 60 miles, are the probable localities of this metal. The distances, however, of this village above Natchitoches and of these localities from the village are variously stated.

"We are informed by the Indians," says Captain Glass, "of a remarkable piece of metal some days' journey to the southward (of the Pawnee village) on the River Brassos," but he subsequently speaks of proceeding south and west in going to the mass. "The Indians informed me that they knew of two other smaller pieces, the one about 30, the other about 50 miles distant" (probably from the Pawnee village). Captain Glass gives no estimate of the whole distance from Natchitoches to the Pawnee village; but, from intermediate distances mentioned, he seems to have considered it about 400 miles.

Doctor Sibley frequently conversed with Captain Glass and others of the party which went in quest of this metal. He states the distance from Natchitoches to the place where the transporting party lost their horses, which must be about the distance from Natchitoches to the Pawnee village, as nearly 400 miles by land; and the distance by water from the place of embarkment to Natchitoches as nearly 1,000 miles.

John Maley traveled in these regions subsequently to the removal of the large mass, but visited one or more smaller masses. "Crossing the river," he says, "at the Pawnee village, we took a southwest course over large ledges of limestone, and extensive prairies. After a journey of three days, we were conducted by the Indians to this metal. It lay a few miles from the mountain which appeared to be the same that I have before described as running parallel to the Red River." He does not state whether he saw one piece or more, but he afterwards stipulated for "the two pieces of metal." The Pawnee village, he says, is 1,500 miles above the confluence of the Red River with the Mississippi.

Judge Johnson, being in company with Mr. Maley some years since, entered into conversation on this subject. According to his recollection he was informed by Maley that "the pieces were found in the midst of an open sterile plain lying near each other and appearing as if broken and scattered in the fall of one entire mass." "The place was described by Maley as about 200 (400?) miles, a little north of west from Natchitoches, on (near?) the ridge between the waters of the Red River and the Rio Bravo."

The readers of this journal will recollect some "Notices of the geology, etc., of the regions around the Mississippi and its confluent waters," by L. Bringier, Esq., of Louisiana, who traveled in this region in 1812.

Mr. Schoolcraft, who states that the large mass was found about "one hundred miles above Natchitoches," must have been misinformed concerning the distance.

The following hints given by Mr. Wm. Darby, to whose travels the public are indebted for much important information concerning the western part of our country, are probably as definite as can at present be obtained. "If with one of Mr. Melish's maps of the United States in your hand you run your eye up Red River to the Pawnee village you will perceive a small creek entering Red River a short distance below the village. This creek is called by the French hunters and traders Bayou Bois d'Arc. It was at its mouth that the transporting party reached Red River with their prize. Continue your glance upon the map a little south of west, to the headwaters of the River Brassos a Dios, and you will find the words Haywa Wandering. Through the latter you will perceive a small creek represented flowing south into the Brassos. From comparing the account of their journey from Red River and of their return to that stream I am induced to believe that the latter creek flows from or near the place where the mass of iron was found. The place is about latitude 32° 20′ north, and longitude 20° West from Washington City. They must have advanced across the upper streams of the Trinity in their expedition. That part of Mr. Melish's map was constructed almost entirely from my papers. When the manuscript lent me by Doctor Sibley was in my possession I collated it as carefully as was in my power with draughts of the country which I had previously collected, and upon my map traced as nearly as possible the route which the party pursued. I can not, it is true, guarantee the accuracy of the delineation, as I never was myself upon Red River above the limits of Louisiana, but from the pains I took to arrive at correct results I think that the general representation may be depended upon with much confidence."

Aided by these directions alone a traveler might experience some difficulty in finding the masses now remaining in that region, but it will probably never be difficult to obtain guides from among the Indians. A mineral substance so remarkable generally engages their attention and often their veneration. These masses of iron before they were visited by our countrymen were among the Indians objects of notoriety, and it is by no means probable that their notoriety has diminished since adventurers have manifested such earnestness to obtain them.

Some interesting remarks upon the native iron of Louisiana by Colonel Gibbs are published in Bruce's Journal, page 218, with a concise account of similar masses from other countries. Colonel Gibbs was the first to make the interesting observation of the occurrence of crystals in native iron; he discovered two of an octahedral form in the iron of Louisiana.

There can be no reasonable doubt that the huge masses of malleable iron from Louisiana are of meteoric origin, and thus their history is rendered extremely interesting. All who have seen them in situ agree that they appear to have been deposited in consequence of some extraordinary natural occurrence and that it is impossible they should be the product of art. The similar composition of the various masses of malleable iron which have been found in different parts of the world, on or just beneath the surface of the earth, affords almost decisive proof of their common origin. The experiments mentioned in the notice quoted from Doctor Bruce would indicate that the large mass in New York forms an exception to this similarity of composition, but experiments instituted more recently by Professor Silliman and stated by Colonel Gibbs in the notice already alluded to, have detected nickel in this mass. There is much reason to believe, therefore, that it had a common origin with numerous other masses found in various places and containing malleable iron and nickel, some of which are known to have proceeded from meteors.

Shepard [4] gave in 1829 a detailed description of his analysis of the meteorite which yielded:

Fe	Ni	
90.020	9.674	=99.694

From the similarity in composition to the meteorite of Santa Rosa he concluded that "they were derived from one and the same meteorite which traversed the atmosphere of our planet in a direction lengthwise of the American Continent." He also gives a determination of the specific gravity as 7.543.

Notice of the gift of the meteorite to Yale College and dimensions of the mass were given in the American Journal of Science in 1835,[5] as follows:

The history of this iron has been given in this journal.[3] The first notice of it was published in Doctor Bruce's Journal in 1810 and it was there stated that it contained no nickel; a subsequent examination by Professor Silliman detected that metal, and a more exact analysis by Mr. Charles U. Shepard [4] ascertained the existence of 9.67 per cent of nickel in this very remarkable mass. It was for many years deposited in trust in the Museum of the Lyceum of New York by the late Colonel Gibbs, who had early purchased the specimen. That gentleman's lamented death was mentioned in the American Journal of Science, vol. 25, p. 214. Recently his respected lady, Mrs. Laura Gibbs, with the approbation of those concerned, has generously presented this magnificent mass to the cabinet of mineralogy of Yale College, thus causing it to be associated with the splendid collection, the Gibbs Cabinet, which was amassed by the labor and munificence of him whose name it bears and to whose memory we trust it will long continue to do honor. In this collection, unrivaled in the United States and surpassed in few other countries, the meteoric iron of Louisiana is, without doubt, the most important specimen.

A more particular notice of it may be given on another occasion. Its length is 3 feet 4.5 inches, its greatest breadth 2 feet 4 inches, and its greatest height 16 inches. Its weight is 1,635 pounds, being more than that of the mass found by Professor Pallas in Siberia which is now in the Imperial Museum at St. Petersburg.

The Gibbs meteoric iron is, therefore, the largest piece in any collection in the world, although there are masses many times larger lying in the wild regions of Mexico and Peru and perhaps elsewhere.

Shepard [6] quotes an observation of the artisan, Mr. Abbot, who polished the face of the mass at Yale College, to the effect that in the process of polishing the dust abraded, especially when rendered pasty by oil or water, arranged itself in lines resembling the outline of mountain ranges. Shepard ascribes this to lines of magnetic iron in the mass and stated that he found by solution of the Texas iron that it contained magnetic oxide of iron.

Partsch [7] describes several pieces in the Vienna collection as hard compact iron mixed with pyrrhotite, showing complete, finely striated Widmannstätten figures on etching; on fracture showing a foliated structure.

Silliman and Hunt [8] made a study of the meteorite, and gave their results as follows:

After this mass was presented to the collection in Yale College by Mrs. Laura Gibbs (widow of Col. George Gibbs, so well known to all cultivators of mineralogy), a portion of the smaller end was sawn off with much difficulty, which when reduced to a smooth surface, gave a brilliantly polished face about 8 inches in diameter, on which is engraved an inscription commemorative of Colonel Gibbs and the donor, and the weight of the mass, 1,635 pounds. This section revealed in a very perfect manner the crystalline structure of the mass, by the broad octahedral cleavages which appeared at one or two points where a fracture was made. By a planing machine, the surface of the portion which was removed was rendered quite smooth and level, and after being well polished, it was washed with dilute nitric acid. The lines of crystallization at once made their appearance in the most beautiful manner. The action of the acid was continued until the lines were etched boldly enough to take ink and give an impression. The mass was so imbedded in type metal as to be capable of passing the copper plate press, and the impressions were then taken, of which the accompanying plate is one. This mode of proceeding, causes the iron to record its own crystalline character in the most faithful manner. This crystalline structure of metoeric iron is found in most but not in all the specimens of such iron which have been examined. Those who have seen the work of Schreibers will remember the beautiful structure of the Agram iron, and many others developed by the acids. The Alabama meteoric iron has,

however, no distinct crystalline structure. The Columbia, South America, has very little; and the supposed meteoric iron from Oswego, or Scriba, in New York, has none.

The Texas mass is a magnet; its greatest diameter is nearly in the magnetic meridian, as it is now placed, and in this situation it possesses true polarity. One of the artisans employed in finishing up the polished face noticed that the filings of the iron arranged themselves on the face in lines parallel to the crystalline planes, as if influenced by magnetic attraction. No large masses of pyrites were observed in this mass, though so abundant in the Lockport iron. This mineral is, however, not entirely wanting in the Texas iron, as is shown by chemical examination; and one or two small lumps of pyrites were encountered by the saw in cutting the section before mentioned.

Very soon after the section was made, both of its opposite faces were observed to be bedewed with moisture. This was washed off with distilled water and the washings tested for chlorine by nitrate of silver, with abundant evidence of the presence of this element. This exudation soon ceased, and the chippings of the iron examined by solution in pure nitric acid, and testing with nitrate of silver, gave no further evidence of the presence of chlorine. We conclude, therefore, that this iron probably contains in its interior parts a small portion of chlorine, which has escaped from its surface, and hence only the deep section of the mass gave evidence of its presence.

* * * * * * * * *

When this iron is dissolved in hydrochloric acid (A) a very small amount of insoluble matter remains, being only about 5 per cent. This residue is a black powder (B) interspersed with some scales of a leaden gray and containing numerous brilliant metallic plates of a silvery whiteness. It is almost entirely magnetic iron, the brilliant scales being either metallic nickel or an alloy of iron with a large portion of nickel.

The hydrochloric solution (A) afforded no precipitate when treated with sulphuretted hydrogen; and the iron being thrown down from a portion of it by ammonia, the filtrate was examined in vain for cobalt, manganese, and zinc.

The insoluble black powder (B), when digested in aqua regia, was partly dissolved, while another portion remained, consisting of flakes of graphite, or at least of a very incombustible carbon containing a little iron. Sulphuretted hydrogen passed through the solution gave a yellowish brown precipitate, which was dissolved by hydrosulphuret of ammonia (C), leaving only a trace of sulphuret of copper. The soluble portion (C) was precipitated by acetic acid, and its color appeared to be orange, but was somewhat obscured by free sulphur. The results obtained from its examination were anomalous and rather unsatisfactory. It fused with niter and carbonate of soda, forming a mass which was soluble in water without residue, and whose solution nitric acid did not sensibly affect. Treated with nitrate of silver and a dilute solution of ammonia, with reference to the detection of arsenic acid, it gave a white precipitate in place of the red-brown of the arseniate of silver. A part of the solution was treated with acetate of lead, and the precipitate obtained, when reduced before the blowpipe, have a globule of lead, which at a red heat evolved white inodorous fumes resembling antimony. A want of sufficient material prevented any further examination, and the question of its true nature is consequently yet unsettled. Antimonic acid is precipitated from its salts by any strong acid, which was not the reaction of the substance under examination. If not antimony, it is probably a new body hitherto unexamined, although such a conclusion requires further evidence to warrant its correctness.

The analysis of 100 parts of this residue (B) gave—

Iron	31.2
Nickel	42.8
Phosphorus	4.0
Carbon	5.0
Antimony (?) and copper	9.3
	92.3

The iron in (B) is doubtless in the state of magnetic oxide, and as such would make up the deficiency in this analysis.

The proportion of nickel and iron in the Texas meteorite seems to vary. The mean of several analyses gives us—

Iron	90.911
Nickel	8.462
Insoluble (phosphurets, etc.)	0.500
	99.873

The nickeliferous iron, or that part of the mass most rich in nickel, seems to have been segregated from the general mass, and forms the elevated lines of brilliant whiteness which appear on etching a polished surface of metal.

Rose [9] classed the meteorite as a fine-grained, alloyed, uniform, and malleable iron.

Wright [10] gave the following account of an examination of the meteorite for gases:

The first trial was made with a piece of meteoric iron, which is a fragment of the great Texas meteorite, in the cabinet of Yale College. This meteorite, of which a description has been published, is a large mass weighing 742 kgs., having the following composition:

Fe	90.91
Ni	8.46
Insoluble portion, containing some carbon	0.50
	99.87

The chips produced by the borer were mostly very small particles. Much of the metal was reduced to powder, and the coarser portions were crushed in the process of boring, so as to destroy the solidity of the iron and break up its structure. A quantity of the borings representing 0.384 ccm. of the solid iron were placed in the glass tube, which was then fastened in its place. The stopcock was closed and the pump set in operation. When the gauge stood at 17 mm. the cock was momentarily opened, and then closed. The gauge rose to about 100 mm., and when the pump had brought it down again to 17 mm. the spectroscope was applied to the vacuum tube. The red hydrogen line was seen bright, the rest of the spectrum having the ordinary banded structure due to nitrogen and oxygen. As the exhaustion proceeded the other hydrogen lines appeared, and when the tension was reduced to 4 mm. both $H\alpha$ and $H\beta$ were bright and distinct. $H\gamma$ was visible, though less prominent. The carbon bands also were distinctly seen. At 2.5 mm. pressure the stopcock was opened, causing the gauge to rise 12.5 mm., after which it remained nearly stationary for 15 minutes, although the pump was in action. A simple calculation shows that the first rise of 12.5 mm. is just what should have been produced by the air contained in the tube with the iron. But the fact that the gauge maintained this position for a considerable time, while the pump was continually withdrawing the air, shows that the iron gave off a portion of its gas without the application of heat, and it was repeatedly observed in other experiments that when the stopcock was open and the pump not in action, the gauge continued to rise very slowly, sometimes as much as 2 mm. in an hour or two.

A gentle heat was now applied to the tube containing the iron by means of a Bunsen burner. This brought the gauge in a few minutes to about 6 mm., and produced a marked change in the appearance of the vacuum tube, which before had the appearance of an ordinary hydrogen tube. The light in the broad portion became a straight, hazy stream of a dull greenish-white color, very similar to that given by a tube containing either of the oxides of carbon. After the tube had been exhausted to 2 mm., heat was again applied rather more strongly than before, but still below redness, carrying the gauge to 9 mm. in about 10 minutes, the effect upon the spectrum being merely to increase the intensity of the carbon bands. The tube was now wrapped with copper foil, and the temperature, by means of a Bunsen flame, carried to low redness, so that the glass softened and began to yield. But a small quantity of gas was given off, the gauge at the end of 10 minutes standing at 5 mm. The stopcock being closed, the exhaustion was continued to 1.5 mm. At this point the spectrum was nearly the same as before, but was somewhat less brilliant. Certain other lines appeared in the spectrum, of which mention will be made in a later paragraph.

Some months later Wright[11] stated the amount of gases obtained from the meteorite to be as follows:

Temperature	CO_2	CO	H	Volumes
500°	9.76	8.43	81.81	1.10
Red heat	2.18	48.58	49.24	0.19

Brezina[12] classed the meteorite with the Murfreesboro group of the medium octahedrites and remarked concerning it as follows:

The deeply etched specimen in the Vienna museum does not show hatching, while in all other respects it corresponds with the characteristics of the group. The breadth of the laminæ is 0.6 mm.

Meunier[13] classed it as caillite and described the etching as follows:

The etching figures are quite normal, kamacite bands medium width and fine grained; tænite well defined and the plessite, moderately abundant, often contains granulations plainly due to the presence of schreibersite.

Various names have been applied to the meteorite according to the places of its find. Of these Cross Timbers would be most nearly in accord with present usage, but Farrington[14] raised objection to this as follows:

There are three "Cross Timbers" in Texas, occurring in Denton, Harris, and Johnson Counties, respectively. None of these is near the locality latitude 32° 7′ N., longitude 95° 10′ W., at which this meteorite is reported to have been found. It is true this locality is a long distance from the Red River as well, but this name has historic usage.

Accordingly, the name Red River is here adopted.

The meteorite is chiefly preserved (1,635 pounds) in the Yale collection.

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Red River, 1875. See Wichita County.

RED WILLOW COUNTY.

Nebraska.
Latitude 40° 22′ N., longitude 100° 30′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found later than 1898.
Weight, 2.77 kgs. (6.13 lbs.).

This iron is described by Barbour[1] as found in Red Willow County, Nebraska, later than the York County specimen. Barbour gives two figures showing the shape, which is somewhat elongated and polygonal. One face is said to have been severely pounded with a hammer. Etching brings out indistinct figures which are also illustrated by Barbour.

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REED CITY.

Osceola County, Michigan.
Latitude 43° 52′ N., longitude 85° 32′ W.
Iron. Coarse octahedrite (Og) of Brezina.
Found, 1895.
Weight, 19.8 kgs. (43 lbs.).

This meteorite was described by Preston,[1] as follows:

For the early history of this meteorite I am indebted to Prof. Walter B. Barrows, of the Michigan State Agricultural College, and a clipping written by Professor Barrows from the Michigan Agricultural College Record, published by the same institution.

This meteorite, according to Professor Barrows' statement, was found by Mr. Ernest Ruppert, a small farmer and junk dealer, on his farm in Osceola County, near Reed City, Michigan, while plowing in Spetember, 1895.

The meteorite was later displayed in a hotel window in Reed City, where Professor Barrows saw it in December, 1898, and was told there had been a dispute as to the origin of the specimen, some claiming that it was a meteor from the skies, others that it was a lump of ordinary iron. Professor Barrows saw at a glance from its general character that it was a genuine meteorite, and at that time made an unsuccessful effort to obtain it for the college museum. Other attempts were equally unsuccessful until recently, when the iron was purchased by the college.

In January of this year Prof. Henry A. Ward, of Chicago, visited Professor Barrows to see if he could make arrangements to obtain a portion of the mass for the Ward-Coonley Collection of Meteorites now on deposit in the American Museum of Natural History in New York. In consequence of this visit the mass was sent to Rochester, New York, for slicing.

The meteorite on reaching Rochester, before cutting, was a semicircular or ham-shaped mass, 10 by 21 by 26.5 cm. in its greatest diameters, of which one side is a comparatively smooth convex surface, showing no distinct pittings. The opposite side is much more irregular in form, slightly concave, with three prominent and numerous small characteristic pittings. On the upper edge of this face is a hackly fracture, oblong in shape, 4.5 by 10 cm. in diameter, where a piece, less than a pound according to Professor Barrows, was broken off by the finder in an effort to discover what made the "stone" so heavy. The surface of this fracture, like that of the entire mass, being much oxidized, so that the nickeliferous iron is not visible. On one edge there is a large, irregular pitting some 10 cm. long and 5 cm. deep. The whole mass is of a reddish-brown hue, intermingled with large irregular patches of an ochreous-yellow color. On no part of the iron was the true crust observed. Its weight was 43 pounds 11 ounces, or 19.8 kilograms.

Following the directions of Professor Ward, a few cuts were made parallel to one of the edges and commencing just within the edge of the deep pitting mentioned above. On polishing and etching these cut surfaces we found that the iron was octahedral in structure, with well-marked Widmannstätten figures. A feature of this iron is the fact that it etches so readily that the Widmannstätten figures were slightly outlined on an ordinary polished surface, without the use of acid or any other solvent.

The etched surfaces have numerous fissures from 0.5 to 1.5 mm. in width and from 5 to 65 mm. in length, partly filled with troilite but mainly with schreibersite. These fissures occur at various angles toward each other, thus breaking to some extent the regularity of the Widmannstätten figures, and are invariably entirely surrounded by kamacite bands. The kamacite bands average from 1.5 to 2 mm. in width, with the broadest bands generally surrounding the schreibersite-filled fissures. The plessite patches which are quite prominent on the etched surfaces show clearly the alternating layers of kamacite and tænite (so-called Laphamite lines), a feature that was first distinguished in another Michigan iron, that of Grand Rapids. On no section were rounded troilite nodules, so characteristic of iron meteorites, found.

The character of the etched surface of this meteorite in many respects resembles that of Cuernavaca, but the kamacite blades are much broader and longer than in Cuernavaca, thus making the figures much more prominent.

An analysis of this meteorite, made for Professor Ward by Prof. J. E. Whitfield, of Philadelphia, gave the following results:

Fe	89.386
Ni	8.180
	97.566

Specific gravity, 7.6.

From the close proximity of the farm, on which this meteorite was found, to Reed City we will designate it as the "Reed City Meteorite."

The main mass of this iron was returned to the Michigan Agricultural College, while the smaller end and one slice, weighing 2.9 kilograms, were added to the Ward-Coonley Collection of Meteorites.

Brezina [2] grouped the meteorite with Cacaria and Hammond as a Hammond octahedrite, the characteristic of which is "lamellæ blended with dark or black points."

Cohen [3] regards the members of this group as octahedrites which have received their peculiar structure through softening. This he states has occurred only in a moderate degree in Reed City. He also remarks that Reed City is peculiar in an alteration zone found along the natural border which has originated subsequent to the latter. This alteration zone is darker and duller than the interior which retains a weak oriented sheen.

The meteorite is chiefly preserved at the Michigan Agricultural College.

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Rensselaer County. See Tomhannock Creek.

RICHMOND.

Chesterfield County, Virginia.
Latitude 37° 33′ N., longitude 77° 25′ W.
Stone. Crystalline spherical chondrite (Cck.) of Brezina; Richmondite (type 39) of Meunier.
Fell 8.30 a. m., June 4, 1828.
Weight, one stone of about 2 kgs. (4 lbs.).

The first account of this meteorite was given by Cocke,[1] as follows:

The fact that stones have fallen from the atmosphere is now universally admitted by men of science, but as there may still be some persons not acquainted with the evidence who may entertain doubts on the subject it may not be amiss to make known the facts connected with an instance of this sort that occurred in Chesterfield County, Virginia, about 7 miles southwest of Richmond, on the 4th of June last—this case is as well attested as any of the kind I ever recollect to have heard of.

Being in Richmond at the time and hearing of the fall, I made some inquiry and obtained a piece of the stone about the size of a pigeon's egg. This resembled so much the only specimen of a meteoric stone I had ever seen that my anxiety to see the whole stone and to learn the facts relating to its fall was increased. It was very much like a fragment

in your cabinet which was part of a stone that fell in Connecticut many years ago, an account of which is published in the American edition of Rees's Cyclopedia. After some inquiry I obtained the greater part of the stone weighing 3 pounds 3 ounces avoirdupois. Most of the exterior is of a dark gray color, about one-third is covered with a black crust. The fracture is granular and of a light gray, interspersed with white metallic points which yield easily to the knife. For several days after the stone was taken from the earth it retained a strong scent of sulphur. The exterior exhibited several cavities from the size of a pea to that of a mustard seed, many of these are filled with earth and with fibers of the turf through which it passed on striking the earth. The whole stone, when entire, was said to have weighed about 4 pounds. Its form is nearly spheroidal and its specific gravity about 4.

The facts in relation to its fall, as I obtained them from a friend who visited the spot on the 7th of June, the day after I got possession of the stone, are as follows:

An overseer and several negroes were at work in a field belonging to Mr. Matthew Winfree about 9 o'clock on the morning of the 4th. An explosion was heard in the direction of Richmond toward the northeast which was at first mistaken for the report of a cannon, and in a short time after there was a noise which was thought at first to be the rumbling of a carriage on a neighboring stony road. In a few seconds, however, it was perceived to be rapidly approaching and presently after seemed to be just overhead, when it passed beyond and ended by a sound resembling the fall of a heavy body on the earth. The persons hastened toward the place from which the stroke proceeded and, after considerable search, found a hole in the turf which seemed to have been made by the entrance of a ball; they dug and got the stone above described. The stone had buried itself about 12 inches; the distance of the hole from the point where the persons were standing when the stroke was heard was found by measurement to be 260 paces.

The person who gave the above account saw the hole the third day after it had been made. The bed from which the stone was taken was entire when he was there and of the size and shape of the body said to have been taken from it.

A specimen will be submitted to the professor of chemistry at our university as soon as possible. I should have great pleasure in sending it for your inspection but for the difficulty of getting it to New Haven.

A later detailed description and account was given by Shepard,[2] as follows:

Since collections of meteoric stones have begun to be formed and a more nice attention to be bestowed upon their differences and resemblances our information concerning their nature, as might have been expected, has been greatly augmented; and although we may still be far from solving the curious problem of the origin of these singular bodies we are, nevertheless, certain that a minute observation of all the facts connected with the subject affords the only rational promise of our ultimately attaining so desirable an object.

In giving a description of the Virginia aerolite I shall in the first place consider the specimen before me in relation to its compound character, or, so to speak, as a rock; and afterwards I shall attempt to point out the nature of the individual substances of which it is composed.

The weight of the fragment is a little short of 2 pounds, which is about half that, as we are informed, of the mass from which it was detached. That portion of the external surface which remains in the specimen indicates that the entire piece was less oval in its figure than is usual in these stones. Besides this difference in general shape the surface exhibits hollow and circular cavities, some of which are half an inch in diameter and about the same in depth; and is invested with the black coating which always accompanies such bodies, although this is interrupted in a few places and nowhere appears to have resulted from a very perfect fusion.

Its interior at first glance reminds one forcibly of certain volcanic rocks. Its color is a bluish ash-gray, interspersed with a sprinkling of white, and here and there with specks of brownish rust. It contains numerous ovoidal, irregular-shaped cavities, varying in size from one-tenth to half an inch in diameter, which are lined in many instances with brilliant metallic crystals. Its compound character becomes sufficiently obvious on bringing it near the eye, when it appears to be composed principally of a bluish-gray substance, in globular masses, from the size of a mustard seed to that of a pea, and a white loosely cohering mineral, the former in much the largest proportion. After these, on closer inspection, are visible, minute-hook shaped, and sometimes slightly flattened globular masses of a metallic nature which are often partially coated by rust, and minute steel-gray grains and crystals, which for the most part occupy the cavities before mentioned, and are sometimes arranged so as to resemble the characters used in the eastern languages. Besides these, by the aid of a microscope, we discover occasionally a greenish transparent laminated substance, and more rarely a honey-yellow mineral in minute grains.

In comparing it in its general aspect with such meteoric specimens as the cabinet of this college embraces, we observe in it a considerable resemblance to the Weston aerolites. Like these, the two substances of which it is chiefly composed are in masses sufficiently large to appear quite distinct to the naked eye, although from the description already given it will be perceived that it differs considerably even from them by its numerous cavities and their crystallized contents. It differs very essentially from the Maryland stones which are almost wholly made up of a white feldspathic substance, as well as from those of l'Aigle and Stannern, the former of which being quite compact and homogeneous, and the latter abounding mostly in albite.

The firmness of the Virginian stone is superior to that of either of those above mentioned except perhaps those of l'Aigle, it requiring a pretty smart blow of the hammer to produce a fracture and the small masses refuse to separate by the mere strength of the fingers. Its specific gravity, as determined in two fragments, one weighing 82.3 grams and the other 38.5, was 3.29 and 3.31.

After these observations upon the general character of the specimen under examination I proceed to the separate description of the minerals it contains.

1. *Chrysolite.*

The globular-shaped bodies which compose the chief part of the Virginia aerolite are thus denominated, because in their mineralogical characters they approach very closely our species of chrysolite. I offer the following description of its characters:

External shape spheroidal, or subangular.

Structure lamellar, cleaving in two directions; at right angles to each other, or as nearly so as the perfection of the planes will allow us to observe. One of these cleavages is effected with greater ease than the other and presents imperfect horizontal striæ. The lamellar structure is often interrupted by a subconchoidal fracture.

Luster vitreous and splendent in the most perfect cleavable masses, but glimmering only on the conchoidal surfaces. Color gray, often with a tinge of blue, and rarely olive green. Translucent on the edges, and in a few instances transparent.

Hardness equal to that of crystallized adularia, the one impressing the other only when great mechanical violence is exerted. It scratches the crystallized pyroxene of Mussa.

Specific gravity was determined upon a mass, which before its fracture into two pieces, weighed 6.1 grams; the entire mass gave 3.3 and the largest fragment 3.33. Another mass weighing 3.4 grams gave a specific gravity of 3.90. The mean of the three experiments is 3.259.

Chemical examination.—Before the blowpipe, in small fragments, with the most intense heat that could be urged, it fused with ebullition upon its thinnest edges into a shining black glass, and the fragment became immediately attracted by the magnet. With borax, in powder, it dissolved, forming a greenish transparent glass. With carbonate of soda it entered into fusion with difficulty, becoming transparent or nearly so in the full heat of the blowpipe, but immediately turning dark-reddish brown and becoming opaque on being removed from the flame and finally changing to white. With microcosmic salt it dissolves with readiness and the glass assumes a deep straw-yellow color which on cooling becomes a paler tinge and contracts a degree of cloudiness.

* * * * * * * * *

Analysis.—A. 17.8 grams reduced to powder were mingled with double their weight of potash and 10 grams of nitrate of potash. The mixture was kept at a red heat in a silver crucible for one hour. The calcined mass which had evidently undergone fusion presented a yellowish-green color which it communicated to its solution in water. On the addition of nitric acid the fused mineral became perfectly soluble, with the exception of a few white flocculi of silex which were seen floating through the solution.

B. The nitric solution was evaporated to dryness, in which state it was kept at a heat of 212° for upward of half an hour to ensure the complete decomposition of the nitrate of iron and the separation of the silex. The dried mass, which was reduced to the state of a powder and frequently stirred, assumed throughout a deep reddish-brown color. Warm water was now affused and the oxide of iron and silex separated by means of the double filter.

C. This solution (B), reduced by evaporation to a convenient bulk, was boiled for upward of an hour with an excess of carbonate of soda. The precipitate which ensued was washed, dried, and heated to ignition in a platina crucible for twenty minutes, after which its weight was 5.5 grams. Its color was pure white, and upon the addition of dilute sulphuric acid it was wholly taken up with the exception of a few flocculi of silex whose weight it was not attempted to ascertain. The solution was partially reduced by evaporation and set aside to crystallize. In two days it shot into crystals of Epsom salt.

D. The insoluble oxide of iron and silex (B) was heated to redness in a close platina crucible over an alcoholic lamp, after which they weighed 11.62 grams. The mixture was now digested with hydrochloric acid until the oxide of iron was wholly dissolved; the silica remained behind in white flocks, and was separated by the double filter, washed, dried, and ignited. Its weight was 7.53 grams. This amount deducted from 11.62 grams gives 4.09 grams peroxide of iron, which reduced by calculation to the protoxide, the condition in which it probably exists in the mineral, equals 3.68 grams.

The constituents of this mineral, therefore, appeared to be in this instance—

Silex	7.53
Magnesia	5.50
Protoxide of iron	3.68
Soda, oxide of chrome, sulphur, and loss	1.09
	17.80

or per hundred—

Silex	42.30	containing oxygen	21.27
Magnesia	31.46	containing oxygen	12.17
Protoxide of iron	20.67	containing oxygen	4.59
Soda, oxide of chrome, sulphur, and loss	5.57		
	100.00		

Considering the soda and oxide of chrome as accidental, the preceding analysis, it will be observed, agrees very well with the supposition that the present variety of chrysolite is a compound of one atom bisilicate of iron, with three atoms silicate of magnesia, and its coincidence with the mineralogical formula fS^2+3MS will be still more striking, if we suppose the oxygen of the iron is estimated a little too high, in consequence of the probable union of a small portion

of that metal with sulpuhr, to form the proto-sulphuret of iron, a substance whose mechanical admixture, in a slight degree, with this mineral was sufficiently evinced by our first experiments.

I am aware that the difference in composition between the specimens just examined, and those of the chrysolite analyzed by Klaproth and Stromeyer may seem opposed to the idea of their specific identity; perhaps it might really be so in a chemical system, but their strong affinity in natural properties certainly proves them to belong to the same mineralogical species—the only difference between the common chrysolite and the present substance being that the former possesses a livelier color, a higher luster, and in general a more perfectly conchoidal fracture, though even this disagreement is not always observable for fragments are occasionally met with in the Virginia aerolite which it would be impossible to distinguish from the most strongly marked specimens of chrysolite.

The proportion formed by this mineral in the Virginia stone does not fall short of two-thirds of its entire bulk. I find it also constitutes the principal ingredient in the Weston meteorites and is occasionally seen in those from Maryland. In endeavoring to ascertain if the small black grains disseminated through the Stannern meteoric stones might not be this substance, I was led to conjecture from their easy fusibility before the blowpipe that they were pyroxene, a mineral, from the researches of G. Rose, well ascertained to exist in aerolites.

2. *Feldspar.*

Under this name I allude to one of the most common ingredients of meteorites, although in the present specimen it forms somewhat less than one-fourth of the mass. It is everywhere dispersed through the stone, filling up little interstices and investing the chrysolite in thin coatings.

Mineralogical description.—External shape, exceedingly minute grains, possessed of feeble degrees of coherence, and appearing like powder to the naked eye. Structure lamellar, and visible only with a microscope. Hardness such as not to allow of its impression with the point of a knife. Luster vitreous: color white, rarely with a faint tinge of green; translucent.

Chemical characters.—It was with some difficulty that pure pieces of sufficient size could be obtained for blowpipe trials. A thin scale in the most powerful heat of this instrument melted down into a pearly white translucent glass or enamel. With microcosmic salt it appeared to dissolve, with the greatest reluctance, into a transparent colorless glass, leaving behind small skeletonlike masses of silex. With borax it dissolved with difficulty and without effervescence into a transparent and colorless glass.

The present mineral appears to correspond with that alluded to by Rose in the memoir before mentioned, and which he found to compose nearly half of the Juvénas meteorite. He ascertained that it contained 0.60 per cent of soda: a quantity so small, that he suggests unless it be a new mineral, it belongs to his species—labradorite, a substance better known generally under the name of labrador feldspar. Its general aspect, however, as it appears in the Virginia stone, would render it more probable that it belonged to the variety albite than to the labradorite.

It also forms a large proportion in the Maryland and Stannern aerolite, and exists in the stones of L'Aigle and Weston, though in the last in but very small proportions.

3. *Phosphate of Lime.*

The only remaining earthy mineral distinguishable in the Virginia stone, I take to be the above-mentioned substance. Its proportion in the mass is so trifling that it is scarcely perceptible without the aid of a microscope, and even then only in a few points. When a fragment of the stone is broken down, however, we rarely fail to distinguish a few grains which are at once recognized by their color.

Mineralogical description.—External shape, globular and reniform. Structure, lamellar. Brittle; fracture conchoidal.

Luster, vitreous. Color, honey yellow, transparent. Hardness such as to scratch crystallized arragonite from Bilin, but not asparagus stone; is scratched itself by the knife.

Chemical characters.—Before the blowpipe upon charcoal it phosphoresces with great distinctness, and becomes rounded on the edges without undergoing any perceptible ebullition and without loss of transparency. With microcosmic salt it forms a transparent glass, at first with a tinge of yellow, but becoming colorless when cold. Comparative experiments were made with the asparagus stone attended by similar results.

Several small angular fragments were put into a flask, to which colorless nitric acid was added, and a slight heat applied for nearly an hour, when their complete solution was effected.

I was the more particular in my examination of this substance, not being aware that phosphate of lime had ever before been detected in these stones; and I regret that the smallness of the quantity prevented me from making still farther experiments, by means of which my conclusion concerning its nature might have been rendered quite certain.

4. *Meteoric Iron.*

This hitherto nearly invariable ingredient of meteoric stones is not wanting in the present instance. Its proportion, however, is very small, as may be judged of from the fact that I did not find above 8 grains in breaking down nearly half a pound of stone.

Its form was for the most part that of rounded grains slightly flattened, the largest of which did not exceed a mustard seed in size. It also existed in little hook-shaped masses, as well as in the most delicate filaments, resembling the finest wire, and capable of being straightened out in single pieces to a length exceeding half an inch. Its color was of a silvery whiteness, except in those instances where the fragment was situated in a large cavity, when it was partially invested by rust and in some cases by a thin coating of the protosulphuret of iron.

* * * * * * * * *

Analysis.—From the foregoing trials I inferred that the meteoric iron was alloyed with nickel only, and, accordingly, I endeavored to form an estimate of the relative proportions of these metals by determining the weight of peroxide of iron afforded by a certain quantity of the compound. For this purpose, 3 grams of the mineral were dissolved as usual in nitro-muriatic acid. The solution was perfect, with the exception of 0.05 gram earthy matter, which remained undissolved. Ammonia was added, and the liquid heated for a few moments. The precipitate, separated, washed, dried, and ignited, amounted to 3.96 grams, equal to 2.77 metallic iron; thus, leaving by deduction, 0.18 gram nickel in 2.95 grams of the alloy, or per 100—

Iron	93.90
Nickel	6.10
	100.00

5. Protosulphuret of iron.

This is the only remaining constituent of the Virginia aerolite I have to describe. Although everywhere disseminated through the stone, and almost completely lining its cavities in little grains and semifused crystals, yet such is their minuteness that it scarcely forms a more considerable ingredient than the meteoric iron.

Mineralogical description.—Form: Distinct crystals, of which I obtained three, of sufficient dimensions to enable me, with the aid of a magnifier, to ascertain their shape, and to determine the value of their principal angles by the reflective goniometer. The most perfect of the three, offered only the sides M. M′, and their four adjoining pyramidal planes c, c, c′, and c′, with the truncature a, as seen in the annexed diagram; the other planes of the figure were inferred from the relation of these, the regular six-sided prism being known to be the fundamental form of the species.

M, on M′	120°
— on c	153. 20′
c, on a	117. 30′

Structure: Cleavage imperfect. Brittle. Luster steel-like and splendent. Color, steel-gray upon the crystalline faces; copper yellow on fractured surfaces. Extremely subject to tarnish, of which the steel blue and red form the most frequent colors.

Hardness: Not impressible by steel.

Chemical characters.—Before the blowpipe, on charcoal, it enters into immediate fusion, emitting at the same time sulphurous fumes; the globule formed assumes a deep red color while hot, but turns to a dull black, and becomes strongly magnetic on cooling.

To 0.4 gram in powder was added hydrochloric acid. The flask was fitted with a tube dipping into a solution of acetate of lead. An action immediately commenced, on slightly warming the fluid, and a copious precipitate of sulphuret of lead ensued.

The difference in magnetic properties between the meteoric protosulphuret of iron and the same mineral belonging to our globe, led M. Rose to examine the former for nickel; conceiving that as the sulphuret of nickel of Johann Georgenstadt is not magnetic, a portion of this metal combined with our mineral, might perhaps be the cause of its not affecting the needle. He was unable, however, to detect the smallest trace of nickel in the pyrites of the Stannern stone. Nevertheless, as the common magnetic pyrites possesses but feeble and very variable degrees of magnetism, the slight discrepancy here observed between the two substances in question does not interfere in any force with the idea of their specific agreement.

A further account of the apatite was given by Shepard,[4] as follows:

M. Rumler, in a recent number of Poggendorff, in enumerating certain ingredients in meteorites, after the mention of phosphoric acid, adds, "For Shepard's discovery of this acid in the meteoric stone of Richmond, is still doubtful (*denn Shepard's Entdeckung dieser Saure in Meteorsteine von Richmond ist noch zweifelhaft*)." Although this observation occasioned in me no surprise, since I had stated at the conclusion of my remarks on the mineral, my regret "that the smallness of the quantity prevented me from making still further experiments by means of which my conclusion concerning its nature might have been rendered certain," still it determined me to make new trials for placing the subject, if possible, beyond dispute.

Through the kindness of Professor Silliman, who possesses nearly the whole of the Richmond stone, I was permitted to detach a fresh fragment which brought into view several points of the yellow mineral in question. The most perfect of these, having the size of half of a pin's head, was crushed to powder on a small piece of clean platinum foil, previously fitted to the bottom of an agate mortar. The foil with the crushed mineral thereon was then shaped into a little cup, and a freshly cut piece of potassium pressed into it, so as to be in immediate contact with the powder. The platinum cup and its contents were then forced to the bottom of the test tube (0.25 inch in diameter and 2.5 inches long); and after heating the tube in contact with a live coal, until a slight flash of light was witnessed in the platinum cup, a few drops of water were let fall into the tube. On holding the open end of the tube beneath the nose, a distinct odor of phosphuretted hydrogen was recognized. A few drops of dilute nitric acid were subsequently added; and after digestion for a few moments and neutralization by ammonia, oxalate of ammonia threw down an evident precipitate.

The foregoing experiment clearly establishes the presence of phosphoric acid in the mineral; and the precipitate with oxalate of ammonia, taken with all the circumstances detailed in my mineralogical account of the substance, leave scarcely a doubt of its being combined with lime, in the form of phosphate of lime.

Partsch [5] described the meteorite as follows:

Groundmass dark gray, sprinkled with light gray and rusty brown spots. The groundmass contains minute cavities and shows numerous spherical aggregates some of which are dull green. Pyrrhotite is present in quantity in minute grains, and as in many other meteorites shows more plainly on a broken than on a polished surface. Iron is moderately abundant. Some of the cavities are coated with pyrrhotite of spherical form and variegated color. In one depression an iron grain is visible. The crust is dull, porous, and apparently easily separable. It is a remarkable meteorite and has a characteristic appearance.

An additional note by Shepard [6] was as follows:

This small and highly interesting stone seems to have been but imperfectly invested by the customary black crust. The natural outside of the fragments examined possessed the usual smoothness of surface, but were only partially melted. It does not appear that any more perfect coating has ever been attached to the surface. Within, the general color is a dark ash-gray. Interspersed through the mass, however, are freckles of a whitish mineral, which is probably howardite. The gray portion consists of olivinoid and forms at least nine-tenths of the earthy portion of the stone.

Rose [7] classed Richmond among the trachytic olivine-bearing coarse-grained stone meteorites. He also disagreed with Partsch's observation that pyrrhotite was more abundant than nickel iron in the meteorite, stating that the piece in the Berlin collection was of an opposite character.

Rammelsberg [11] made two analyses with results as follows:

	I.		II.	
	Soluble portion.	Insoluble portion.	Soluble portion.	Insoluble portion.
SiO_2.....	39.27	52.37	39.30	53.74
Al_2O_3.....	.....	4.97	.....	5.32
Fe O.....	18.85	13.96	18.21	13.17
Mg O.....	41.88	23.28	41.69	22.23
Ca O.....	.....	5.43	0.80	5.54
	100	100	100	100

From which he deduced the following composition:

Nickel iron	8.22
Iron sulphide	4.37
Chrysolite	45.73
Insoluble silicates	41.68
	100

The insoluble silicates he regarded as augite with bronzite and perhaps diopside.

Brezina, in 1885,[16] classed Richmond among the crystalline chondrites with the following remarks:

The Richmond stone holds a peculiar place, since its structure is firm but not solid as are the other crystalline chondrites. It forms a somewhat higher grade of crystalline structure in which the individual constituents may be completely separated. It might almost as well be placed among the spherical chondrites, since the chondri, upon breaking the mass in two, sometimes remain whole and sometimes break.

Cohen [17] remarked that Shepard's drawing of the crystals of iron sulphide in the Richmond stone were a copy of Rose's. Also that the influences which produced the crust zone had in this meteorite affected broader areas, giving rise to a black groundmass.

Brezina [18] in 1895 transferred Richmond to the group of spherical crystalline chondrites.

The meteorite is distributed, Yale possessing 305 grams, the British Museum 169, and Amherst 155.

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16. 1885: Brezina. Wiener Sammlung, pp. 191 and 233.
17. 1894: Cohen. Meteoritenkunde, pp. 200, 283, and 317.
18. 1895: Brezina. Wiener Sammlung, pp. 259 and 260.

RICH MOUNTAIN.

Jackson County, North Carolina.
Latitude 35° 2′ N., longitude 83° 2′ W.
Stone. Veined intermediate chondrite, Cia.
Fell 2 p. m. June 30, 1903; described 1907.
Weight, 668 grams (1.2 lbs).

This meteorite was described by Merrill [1] as follows:

The meteorite described below was received at the United States National Museum from Prof. H. H. Brimley, curator of the State Museum at Raleigh, North Carolina. To him I am also indebted for most of the information relative to its fall.

The exact date of fall can not be given but it is stated as "about the 20th of June, 1903, and 2 o'clock in the day." Concerning the phenomena of the fall, the following is gleaned from a letter of Mr. E. A. Cook, of Rich Mountain, to Mr. Brimley:

"It [the meteorite] was going nearly due south; I did not see it, though it passed directly over my place. It made a rumbling sound something like a tornado of wind or the pouring of water." The explosion Mr. Cook compares to a "large blast," the first and loudest being followed by lesser sounds compared to the shooting of a self-acting pistol. Reports from the adjacent parts of South Carolina were to the effect that the passage of the stone was heard and seen there and it created great excitement. It was also seen by people living 10 miles northwest of Rich Mountain, who reported it as looking like a ball of fire the size of a flour barrel. The single piece secured passed through the top of a green tree, cutting off the leaves and small limbs, and struck the ground not more than 40 feet from a man standing in a field, who dug it up and gave it to Mr. Cook. Other fragments were reported to have been found across the State line in South Carolina. Such, however, have not come into the possession of the writer, nor has he been able to get track of them. The single piece which has thus far come to light weighed 668 grams; actual size, 122 mm. in length, 76 mm. in breadth by 44 mm. in thickness. This is obviously a freshly broken piece from a larger mass, the crust on the flat surface being very thin, not nearly equal to that on the rounded surface. There is no fluting or grooving to indicate the orientation during flight, but the smoothness of the rounded point suggests at least that this formed the nose or breast of the stone in its passage through the air. The proximity of this locality to that of the Hendersonville meteorite recently described by the writer might at first suggest that it represented a part of the same fall. The testimony of eyewitnesses to the phenomenon and the freshness of the sample as compared with the last named, however, preclude any such conclusion. The close similarity of the stone to that of Bath Furnace, Kentucky, as described by Ward, is also worthy of note, although there is an interval of over six months between the dates of fall.

The black crust is dull and somewhat rough. On the recently broken, flat surface, where the crust is thinnest, and on the rounded surface the metallic-iron particles project, seemingly having resisted the frictional heat of the atmosphere more than did the silicate portions. A cut surface shows a gray, compact, indistinctly chondritic structure, with gray and more rarely white "kugels" and an about medium scattering of metallic iron and troilite. The texture is coarser, less compact, and in color a lighter gray than that of the Hendersonville stone, but closely like that of Bath Furnace. The stone is traversed by numerous fine, threadlike, black veins, often branched, and without common orientation. Although sought for with care, no certain indication of movement along these lines could be discovered. Indeed, the evidence was almost wholly to the contrary, the veins sometimes passing directly through the chondri without evident relative displacement of the portions thus separated.

Under the microscope the structure is somewhat obscure, the chondrules being often fragmental and not strongly differentiated from the fine, pulverulent ground. Olivine and enstatite, the latter prevailing, with an occasional monoclinic pyroxene, are the principal silicate constituents, the first named in chondrules of the polysomatic and barred type, and in scattered granules; the enstatite in cryptocrystalline radiate forms, granules, and occasional relatively large, almost colorless and clear plates. Interspersed with these are minute colorless areas, showing no crystalline outlines, cleavage, or other evidences of crystal structure, little relief and polarizing only in light and dark colors.

These areas are at times so abundant as to form the base in which the other constituents are embedded. They are evidently composed of a single mineral, the optical properties of which are so ill-defined as to make a satisfactory determination impossible. At times it is quite isotropic, but more commonly it shows a faint double refraction, and in a very few instances the attempt at obtaining an interference figure resulted in a very indistinct dark brush, suggestive of a biaxial mineral. Between crossed nicols, if not always dark, it shows no definite extinction plane, but the dark wave sweeps over the surface much as in an isotropic mineral in a condition of strain. In a single instance one of these areas adjoined and partially inclosed a minute particle showing the parallel twin bands of a plagioclase feldspar. The mineral is regarded as unquestionably the same as that so common under similar conditions in the meteorite of Alfianello, Italy, and which has been considered by V. Toullon as maskelynite, a conclusion adopted by Tschermak. The present writer also noted its occurrence in the recently described meteoric stone from Coon Butte, Arizona. Compared with terrestrial rocks, it is of interest to note that similar structures and associations of pyroxene or olivine, and what are unquestionably feldspars, are found in peridotites of the wehrlite type, as described by the writer some years ago from the Red Bluff region of Montana.

In addition to the above is an occasional plate of a colorless silicate likewise of a doubtful nature. The plates are of irregular outline, faintly gray or almost completely colorless, and show very faint, short, sharp cleavage lines, and rarely any inclosures of other minerals which are so conspicuous a feature of the maskelynite. The surface viewed under a high power has a peculiar roughness, in which also it differs from the above. Between crossed nicols it gives weak polarization colors, and is optically biaxial, though good interference figures are not obtainable. The description given by Tschermak of a mineral referred to as possibly monticellite would apply equally well to this, though the present writer confesses to a considerable feeling of doubt as to its true nature.

The structure and composition of the stone, as a whole, is comparable with those of Lancon, France, and Bath Furnace, Kentucky (Cia). It will be known as the Rich Mountain meteorite.

CHEMICAL ANALYSIS BY MR. WIRT TASSIN.

A very small portion of the meteorite, 5.8 grams in all, was available for analysis. This was treated in the usual way, the native metals (I), sulphur (II), phosphorus (III), soluble and insoluble silicates (IV and V), and the alkalies (VI), each being determined in separate portions. The values obtained are as follows:

I.	Fe	7.07
	Ni	.73
	Co	.031
II.	S	1.42
III.	P	.03
IV.	SiO_2	18.28
	FeO	9.06
	Al_2O_3	.50
	CaO	.99
	MgO	18.16
V.	SiO_2	23.00
	FeO	4.92
	Al_2O_3	2.10
	CaO	1.51
	MgO	8.27
	Fe_3O_4 (magnetite)	.15
	C (graphite)	.015
VI.	K_2O	.16
	Na_2O	.68

From these several values the approximate composition of the mass may be arrived at as given below:

Iron	7.070
Nickel	.730
Cobalt	.031
Troilite	3.890
Schreibersite	.200
Olivine	46.990
Insoluble silicates	40.670
Magnetite	.150
Graphite	.015
	99.736

In the analyses above given the absence of copper in the native metals and chromite among the compounds is to be noted. Attention is also to be called to the presence of carbon as graphite, occurring as graphitic chondrules, which may or may not be contained in or surrounding particles of the native metals. The occurrence of the graphite is especially interesting, since the relatively large amounts of it do not appreciably affect the color of the groundmass.

The meteorite is chiefly in the possession of the United States National Museum.

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Robertson County. See Coopertown.

Robinson Station. See Cynthiana.

ROCHESTER.

Fulton County, Indiana.
Latitude 41° 5′ N., longitude 86° 15′ W.
Stone. Spherical chondrite (Cc of Brezina); Montrejite (type 38) of Meunier.
Fell 8.45 p. m., December 21, 1876.
Weight, one stone of 340 grams (0.9 lb.).

The first account of the meteor which produced this meteorite was given by Newton [1] as follows:

On the evening of Thursday, December 21, 1876, a meteor of unusual size and brilliancy passed over the States of Kansas, Missouri, Illinois, Indiana, and Ohio. In many respects it is worthy of special record. From newspaper notices that we have been able to collect, from a few private letters, and from some letters kindly sent us by Professor Henry from the Smithsonian Institution, we are able to give a general account of the body.

It was first seen, so far as known, over the State of Kansas, and probably as far west as the center of the State. It passed nearly over and probably north of the cities of Topeka and Leavenworth, being there at an altitude of about 60 miles. It crossed the Mississippi between Hannibal and Keokuk, but nearer to the former place. Over the center of the State of Missouri one or more explosions occurred, and shortly after crossing the Mississippi it broke into several fragments. The breaking up continued while it was crossing the States of Illinois, Indiana, and Ohio. A loud explosion is reported as far east as Concord and Erie, Pennsylvania. The meteor consisted in fact of a large flock of brilliant balls chasing each other across the sky, the number being variously estimated at from a score to a hundred. This flight is of peculiar interest because of the long continued violent disintegration.

The region round Chicago was overcast, and though the clouds were lighted up in a most remarkable manner, no sound seems to have been heard. In like manner no sound is reported from St. Louis. But over all the region of central Illinois between these two cities a terrific series of explosions was heard. In Keokuk, Iowa, it was heard, but not elsewhere in that State, so far as appears from the accounts. A rumbling is reported as far south of the track as Bloomington, Indiana, 120 miles distant, but whether it was caused by the meteor is doubtful. Yet over the northern part of Indiana the passage of the body was followed by loud explosions.

Whether a portion of the body pursued its way onward over New York State and out of the atmosphere is doubtful. The path was nearly parallel to the earth's surface and might easily be in its latter part upward. But if the sky was then clear over western New York the meteor would in such case certainly have been seen in that region.

The path was about N. 75° E., and was nearly or quite a straight line and not less than 1,000 miles long. The duration of flight was of course variously estimated from 15 seconds up to 3 minutes, and yet no one probably saw the body through more than a fraction of its path.

It entered the air in a course differing only about 30° from the earth's motion and was overtaking the earth. Its real motion made therefore a still smaller angle with that of the earth. But the relative velocity was so slow, probably not over 10 or 15 miles per second, that the earth's attraction had changed its direction greatly. It must have been coming previous to that change from a point near to and a little south of the ecliptic, in the eastern or southern part of the constellation Capricornus. There appears to be no known meteor-radiant at that time near that part of the heavens.

Following Newton, an account was given by Shepard,[2] as follows:

A fall of a meteoric stone took place at about 8.45 Thursday evening, December 21, 1876. The circumstances connected therewith are drawn from several communications. The first is from Prof. Daniel Kirkwood, of Bloomington, Indiana, professor of mathematics in the Indiana State University, as published in the Indianapolis Journal. Professor Kirkwood's account says:

"Last evening, December 21, about 8.45 o'clock, our citizens witnessed a meteoric display of extraordinary brilliancy. A fireball, described by many observers as surpassing the moon in apparent magnitude, followed by a great number of smaller meteors, was seen in the eastern heavens, moving in an easterly direction. Its first appearance was at a point 12° or 15° north of west and about 10° above the horizon. A remarkable feature of the meteoric group was the slowness of its apparent motion. The time of flight was variously estimated. Most observers, however, think it could not have been less than 3 minutes. Many of the meteors following in the train of the principal bolide were larger than Venus or Jupiter. No attempt was made to count them, but their number was certainly nearly one hundred. Some minutes after the disappearance a rumbling noise was heard, which was supposed to result from the meteor's explosion."

The second is from the Columbus (Ohio) State Journal: "A meteoric display, which, for singularity and beauty, few persons in a lifetime have the good fortune to behold, was witnessed by six or seven persons, myself included, on the evening of December 21, 1876, at just 9 o'clock. Four of us were in the caboose car, and two or three others on the engine of the freight train, due in Columbus at 9.20 p. m., on the Cleveland, Mount Vernon and Columbus Railroad, and within about 4 miles of the depot. At that point the track runs nearly north and south. The cluster or flock of meteors, from 40 to 60 in number, varying in apparent size from a water bucket to that of large apples, were seemingly huddled together like a flock of wild geese and moved with about the same velocity and grace of regularity. The color of their light was a yellowish-red, resembling the light from the red balls of fire thrown out by the explosions of certain kinds of rockets. There was no illumination, nimbus, or trail from them. The display was a little below an angle of 45 degrees from our point of observation, and seemed not over a quarter of a mile distant from the rear end of our train. The course was from west to east, crossing the railroad at nearly right angles. The party on our engine, and our conductor, who was looking out of the rear window of our car, made the discovery at about the same moment, in a westerly direction. When seen by the rest of us, the meteors were just passing over the track and very slowly approaching the earth. I can not pretend to put this statement in scientific form, having witnessed it from a moving train, but simply state the facts as they appeared to myself and others as worthy of note."

The third notice attended one of the specimens sent me and consists of a letter addressed to Professor Kirkwood from Mr. A. J. Norris, the finder of this stone: "Inclosed you will find a specimen of the meteorite. The circumstances under which the stone was found are these: Hearing a rumbling noise, I stepped out of the house and heard the stone fall. I marked the direction of the sound, and the next morning repaired to the field whence it had proceeded, where I discovered it lying upon the snow. I saw two places where it had previously struck and from whence it had bounded to its resting place. No appearance of any other stone was visible in the region. Its weight was about three-quarters of a pound."

The following is a letter (dated Bloomington, Indiana, January 19) from Professor Kirkwood to myself: "You were kind enough to express a wish that I would furnish some notes in regard to the meteor. I have written many letters of inquiry to some of which I have received replies. I have also a number of newspaper accounts of the phenomenon. I regret to say, however, that many of the statements made by observers are so inaccurate and contradictory as to be of little value. Being busy with other matters, I placed nearly all of them in the hands of Professor Wylie." The following conclusions, derived from the observations at Bloomington, Indiana, and Wooster, Wayne County, Ohio, can be relied upon as nearly correct:

"Rev. Dr. Wylie, professor of natural philosophy in the Indiana State University, noticed the point in a tree apparently passed by the meteor. The angle of elevation was subsequently measured and found to be about 15 degrees. But the meteor passed the meridian 131 miles north. These data, making allowance for the curvature of the earth's surface, give about 38 miles as the height of the body when passing the boundary line between Pulaski and Fulton Counties, Indiana. At Wooster, Wayne County, Ohio, the meteor apparently passed a particular point of the steeple of a public building. From this observation the apparent altitude when over Lake Erie, immediately north of the city, was found by Prof. Samuel J. Kirkwood to have been about 24 degrees, corresponding to a true height of 28 or 29 miles. The most western point from which I received a report is Emporia, Kansas. It passed that place a few degrees southeast of the zenith. He thinks the meteor became visible over the northwest corner of Texas, at an elevation of 70 or 80 miles. The estimates of time for the meteor are so discordant that it seems impossible to determine whether it was moving in an ellipse, a parabola, or an hyperbola.

It belongs, by way of eminence, to my order of Oolitic, of the class Litholites, and resembles most closely the Pegu (Indian) stone of December 27, 1857, particularly in the character of its crust and in its pisiform external structure. The two stones are not unlike in color and the facility with which they may be broken, both yielding to separation when in small masses under the mere strength of the fingers. The thickness of the crust in each is double that in the majority of litholites. The general tint of color is also the same in both. In the Rochester stone, however, the shade is less gray, from the greater prevalence of an almost pulverulent, nearly white mineral, in which the dark ash-gray globules are imbedded. This white mineral forms less than one-tenth of the mass. The globules vary in size from a millet seed up to that of a peppercorn. Their shape is almost perfectly spherical, and plainly indicates an origin from fusion, the surfaces of many of them being obviously mammillary, while internally they present a porcelaineous, compact structure.

The globules are probably forsterite, of a variety nearly identical with boltonite. This appears the more likely from the circumstance that those situated just below the crust have the yellowish tint acquired by boltonite after its subjection to heat with access of air; and it is presumable that this alteration of the globules in the meteorite took place on its entrance into our atmosphere when the fusion of the surface occurred.

The white semi-pulverulent basis of the stone I take to be chladnite (Mg_2Si_3). In one of my specimens it shows itself in its characteristic loosely crystalline structure and there closely resembles this species as seen in the Bishopsville (March 25, 1843) meteorite.

The metallic iron (chamasite?), as in the Pegu stone, is very obvious, and rather evenly distributed though probably not exceeding 1 per cent in quantity. In place of being shapeless grains or points, or in curved wirelike fibers, it is semicrystalline in structure, showing occasional rectangular and triangular facets. Troilite is barely visible at two minute points in the specimens thus far examined. Two distinct grains of chrysolite of the size of half a rice grain are present, showing in each case the cleavage, color, and luster of this species as existing in Krasnojarsk meteoric iron. Moreover, these grains have not the perfect spherical form of the forsterite globules.

The specific gravity of a fragment whose surface was one-third crust is 3.65. It may be added in conclusion that the inspection of this rather peculiar stone strongly suggests the idea that the pisiform globules were produced by the sudden fusion of what was originally a chladnitic material (similar to the Bishopville stone), amid particles of chamasite attended by access of oxygen, whereby the silicate of magnesia became converted into the more fusible double silicate of magnesia and iron.

Kirkwood [4] described the meteor as follows:

On Thursday evening, December 21, 1876, about seventeen minutes before 9 o'clock, Bloomington time, a meteor of extraordinary magnitude passed over the States of Kansas, Missouri, Illinois, Indiana, Ohio, Pennsylvania, and New York. I have received communications descriptive of the phenomena from Prof. F. W. Bardwell, of Lawrence, and Rev. J. L. Gay, of Parsons, Kansas; Prof. Joseph Ficklin, Columbia, Missouri; Prof. S. W. Burnham, Chicago, Illinois; Profs. D. E. Hunter, Brookston, and J. B. Roberts, Indianapolis, Indiana; Prof. Samuel J. Kirkwood, Wooster, Ohio; and others in the different States over which the meteor passed. At Bloomington, Indiana, it was observed by Profs. T. A. Wylie, D. D., H. B. Boisen, and C. F. McNutt; also by Rev. James Garrison, Messrs. D. O. Spencer, J. Graham, and many others. A discussion of the observations furnished by the correspondents named gives the following as the meteor's track through the atmosphere.

The body when first visible was about 70 or 75 miles above the earth's surface, at a point southwest from Emporia, Kansas, and not far from the southern border of the State. It passed Emporia a few degrees southeast of the zenith, entered Missouri near the southwest corner of Jackson County; passed very nearly over the towns of Lexington, Keytesville, and Oakdale, Missouri; Quincy, Lewiston, Peoria, and Lorain, Illinois; Winamac, Rochester, and Auburn, Indiana; Bryan and Toledo, Ohio; crossed Lake Erie to a point a few miles south of Erie, Pennsylvania, and disappeared over southwestern New York. This track is not represented by a straight line drawn on the map, but by one somewhat curved toward the north or northwest. Its length is between 1,000 and 1,100 miles, one of the longest meteoric tracks on record. The body passed the meridian of Bloomington, Indiana, 131 miles north of the city, and its apparent elevation as determined by Prof. T. A. Wylie, was 15°. This, taking into account the curvature of the meridian, gives about 38 miles as the altitude of the meteor when over the western part of Fulton County, Indiana. Data furnished by Prof. Samuel J. Kirkwood, of Wooster, Ohio, show the height when over Lake Erie, nearly directly north of that city, to have been 29 miles. The estimated altitudes at other points of the track are less satisfactory.

Some observers in Missouri report an explosion of the meteor when passing over the central part of the State. At Bloomington, Indiana, Prof. H. B. Boisen, who saw the meteor when due west and watched it till it disappeared near the eastern horizon, observed it separate into several parts when nearly northwest, or in the direction of Peoria, Illinois. Rev. James Garrison, who resides 1 mile south of Bloomington, noticed by his clock the time of the meteor's disappearance and also that of the subsequent rumbling sound, together with the violent jarring of his house. The interval was 15 minutes, indicating a distance of 185 miles. The sound and jar of the explosion were heard and felt by hundreds throughout Monroe County, and by many ascribed to an earthquake. In regard to the sounds following the meteor's passage through the atmosphere, the Monthly Weather Review for December, 1876, says: "No reliable accounts speak of any noise heard during the visibility of the meteor, but in from two to five minutes after its passage a shock resembling thunder was heard, which, in the majority of cases, was described as tremendous, shaking the ground and the houses, and was especially alarming to those who, on account of the prevailing cloudiness, were unable to see the preceding meteor. The uniform character of the sound heard at all the stations shows that it was not due to any violent explosion (properly so-called), but was a peculiar acoustic phenomenon, depending on the fact that that portion of the line described by the meteor when nearest to any observer, became, as it were, instantaneously along a length of several miles, the origin of a series of simultaneous sounds which, although in themselves comparatively feeble, were concentrated into a violent sound when they reached the observer's ear." The view here expressed is not sustained by the observations in Monroe and the adjacent counties, as a sound from the nearest point of the meteor's track would have reached Bloomington, if at all, in 10 or 11 minutes.

When crossing Indiana the principal fireball was followed by a train or group of smaller meteors, many of which were superior in apparent magnitude to Venus or Jupiter. The breadth or apparent diameter of this cluster, as seen from Bloomington, was 3 degrees, and its length at least 20 degrees. Its true diameter was, therefore, 5 miles, and its length about 4 miles. These smaller meteors were chiefly the results of the explosions over central Illinois. A final disruption occurred over Erie County, Pennsylvania, several minor explosions having taken place during the passage over Indiana and Ohio.

A fragment of the meteorite fell on the farm of Mr. Andrew J. Morris, 3 miles northwest of Rochester, Fulton County, Indiana. Mr. M., on hearing the meteoric explosion, had left his house, when he noticed a heavy body strike the earth at no great distance. Designating the spot as nearly as he could by a mark in the snow (which was six inches deep), he returned in the morning and soon found where the meteorite had struck in the snow, rebounded, and again fallen close by. The whole fragment weighed about 12 ounces. A part of it was secured by the writer and forwarded to Prof. Chas. Upham Shepard, of Amherst College, Massachusetts. A fragment was also obtained by Mr. W. A. Roebling, of New York, and a third was sent by Prof. E. T. Cox to Dr. J. Lawrence Smith, of Louisville. No analysis, however, has yet been published. The body is peculiar in its structure, being pisolitic and remarkably friable. The fact that other portions of the mass have not been discovered may perhaps be owing to its complete disintegration.

The observations at Bloomington, Indiana, and Wooster, Ohio, indicate that in a flight of 200 miles eastward from Rochester the altitude diminished from 38 to 29 miles. The elevation when over Erie County, Pennsylvania, was almost certainly less than 30 miles, probably not more than 25. After the explosion, near the southwestern border of New York, the meteor became almost immediately extinct. In view of these facts it seems extremely improbably that any part of the mass could have escaped out of the atmosphere. What became of the dissevered fragments, or why none have been hitherto found near the terminus of the track, may be difficult of explanation.

I have not learned that the time of the meteor's visibility was by anyone accurately measured. The slowness of the apparent motion was, however, very remarkable, being compared by many to that of a flock of wild geese. Several observers estimated the duration of flight at nearly two minutes. The velocity with reference to the earth's surface was probably between 8 and 12 miles per second, and with reference to the sun, between 25 and 30.

Smith [5] described the meteorite as follows:

The passage of this meteorite through the earth's atmosphere has left but a small souvenir of its visit. It was well observed at Bloomington, Indiana, latitude 39° 12′ N., longitude 36° 32′ W., by the distinguished astronomer Professor Kirkwood, who communicated to me at the time his observations; and he has subsequently given them more in detail to the American Philosophical Society, with the observations he had collected from others. I will therefore simply give a summary of the phenomena attending upon its flight before describing the chemical and mineralogical characteristics of the stone which fell.

The bolide made its appearance about 9 o'clock p. m., December 21, 1876, and was of extraordinary magnificence. It passed eastward over the States of Kansas, Missouri, Illinois, Indiana, Ohio, and parts of Pennsylvania and New York. Although no observations were made in the two last-mentioned States, still Professor Kirkwood is doubtless correct in defining this as its course. At Bloomington its elevation was 15 degrees. According to the calculation, the length of its observed track was from 1,000 to 1,100 miles, one of the longest on record. Its height is supposed to have been 38 miles above the place where the small fragment fell from it.

In various parts of its track it threw off fragments, accompanied with the usual rumbling noise and commotion in the atmosphere common to the flight of these bodies. When crossing Indiana, the main body was followed by a train of smaller bolides, many of them of the apparent size of Venus or Jupiter. Its velocity in reference to the earth's surface appeared to be from 8 to 12 miles per second. The pyrotechnic display is said to have been transcendently beautiful, hardly equalled or surpassed by any previous occurrence of the kind. The cause of this brilliancy lay in the physical structure of the body, which will be detailed farther on.

The fragment which fell.—The only fragment of this bolide known to have fallen was one found on the farm of Mr. Morris, 3 miles northwest of Rochester, Indiana, latitude 41° N., longitude 86° W. This farmer heard the explosion, and shortly afterwards noticed a body strike the ground not far from him. There were 6 inches of snow upon the ground, and on the following morning he found the stone, which had rebounded to a short distance from the place where it first fell, it not having penetrated the ground. The entire stone did not weigh 400 grams; and, as we have not heard of the fall of any other mass, it is reasonable to suppose that it was dissipated into very minute fragments and dust, as in the case of the Hessle stones and other similar falls.

The manner in which the molten matter of the exterior of many of these meteorites is swept over their surfaces, in shining streaks, covering freshly broken surfaces, shows clearly that this disintegration is constantly and rapidly going on in these bodies during their passage through the air. I have in my collection many fine examples illustrating this fact.

Professor Kirkwood is of the opinion that this bolide never passed out of our atmosphere, which is in accord with my general view on this subject, viz, that a bolide rarely, if ever, gets entangled in our atmosphere without being entirely reduced to fragments or powder.

The stone has been broken up into many small fragments, of which I have fortunately secured a good portion. Others have been lost and a few have found their way into collections. With the exception of the largest specimen in my collection, weighing 95 grams, hardly any other fragment weighs over 30 grams. It is important to treasure these specimens, small as they are, for it is a remarkable stone of its type. It is of the pisolitic variety, very friable, of a gray color, easily crushed under the fingers into light powder (some of it to fine dust), and to small globules, some of them perfectly spherical, of which I have specimens 2 mm. in diameter. It resembles more closely the Aussun stone than any other I know of, although much more friable. This peculiar structure, so often seen in many parts of meteoric stones, has recently attracted much attention, Professor Tschermak, of Vienna, having recently published an interesting paper on the subject.

The specific gravity of the stone, taken with several average specimens, is 3.55. There is nothing peculiar about the coating on the specimens I have examined; it is of a dull black and quite rough.

Chemical examination.—The stony part of the meteorite, separated almost perfectly from the metallic part, still contained a notable portion of troilite that could not be separated mechanically. The amount of sulphur found in that part of the meteorite indicated the amount of troilite present, viz, 3.31.

The stony material, when treated with chlorhydric acid over a water bath, affords soluble part 47.80 per cent, insoluble 52.20 per cent, and is constituted as follows:

	Soluble part.	Insoluble part.
Silica	34. 55	57. 81
Iron protoxide	27. 75	11. 04
Alumina	trace	0. 23
Lime	trace	5. 31
Magnesia	36. 38	24. 97
Chromium oxide	....	0. 10
Soda	0. 46	0. 84
	99. 14	100. 30

I separated some of the globules perfectly free from the intervening matrix, which is easily done by rubbing a piece of the stone between the fingers. Very minute specks of iron could be distinguished upon them, and when pulverized and treated with hydrochloric acid they give about the same result as the matrix, viz, soluble 46.80 per cent, insoluble 53.20 per cent, and the magnesia in the soluble part was 34.48 per cent, showing clearly that they were merely concretions of the matrix of the stone.

The nickeliferous iron, which was separated mechanically, is composed of—

Iron	94. 49
Nickel	4. 12
Cobalt	. 51
	99. 12

The quantity of iron was too small for an examination of the other constituents, as phosphorus and copper, but they were no doubt both present.

Mineral constituents of the stone.—Careful examination under the microscope of the broken surface, as well as of a section rubbed down very thin, shows the stone to be composed of the unisilicates and bisilicates usually found in these bodies, mixed with nickeliferous iron and troilite; nothing like anorthine is distinguishable. The first two minerals constitute the bulk of the stone, and there is possibly more than one variety of each of these minerals present. The nickeliferous iron is quite abundant, though Professor Shepard states that from a casual observation he estimates it at 1 per cent. By the careful method adopted for separating it, I find in two average specimens over 10 per cent. The particles of iron are very bright and lustrous, looking as if they were covered with plumbago, although there is no evidence of the presence of the latter mineral. The troilite is not detected so readily by the eye as it is by chlorhydric acid. One of the spherules was rubbed down to a thin section and examined by polarized light, and in this way it was found to contain both classes of silicates referred to, a fact, as already stated, sustained by chemical examination. I consider the mineral constituents of the Rochester stone to be about as follows:

Bronzite and pyroxene minerals	46. 00
Olivine minerals	41. 00
Nickeliferous iron	10. 00
Troilite	3. 00
Chrome iron	. 15

Meunier [6] classes the meteorite as Montrejite, and Brezina [7] as spherical chondrite. The meteorite is distributed, Harvard possessing the largest quantity, 75 grams.

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Rockingham County. **See Smith's Mountain.**

Rockwood. **See Crab Orchard.**

RODEO.

State of Durango, Mexico.
Latitude 25° 20′ N., longitude 104° 40′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1852.
Weight, 44.1 kgs. (97 lbs.).

This meteorite was first described by Farrington [2] as follows:

This meteorite is an iron mass found about 1852 by a goat herder in an arroya north of the Nazas River, 12 km. northwest of the hamlet of Rodeo, State of Durango, Mexico. The location is approximately 25° 20′ north latitude, 104° 40′ west longitude. Upon the discovery of the iron it was made to do duty as an anvil at a forge for many years. As received at the Field Columbian Museum evidence of its industrial use was to be seen in its having been beaten flat and smooth on one side. The surface so treated was apparent by its smoothness and turned over edges. The meteorite as a whole is irregular in form and without marked orientation. Its extreme dimensions are 12 by 9 by 8 inches (30 by 23 by 20 cm.). Its weight when received was 97 pounds (44.1 kgs.). An attempt had evidently been made at some time to cut off a portion of the mass with a cold chisel, and above this a small surface appears that was filed smooth for etching. In other respects the surface of the meteorite has the natural contours. The surface in general, though irregular, is everywhere rounded, showing no angular or sharp edges. There are many partially defined pittings of various depths and diameters, the largest of these having an elliptical outline and being 4 inches (10 cm.) in length, 3 inches (8 cm.) in width, and about 1.5 inches (4 cm.) in depth. In color the surface of the meteorite is darkened by exposure, but it has nowhere rusted deeply, and in several places the nickel-white color of the metal is visible. In such places Widmanstätten figures often can be seen also. On any polished surface of the meteorite, too, the figures appear nearly as plainly as after etching.

Several complete sections of the meteorite were made in order to determine its interior structure. All show on etching well-defined figures, octahedral in character. The bands (Balken) are more numerous than the meshes (Felder), yet the latter occupy a considerable amount of the total area. Through a belt about 2 inches (5 cm.) in width, running across the middle of most of the sections, a minutely dotted appearance is presented, resembling that described by Brezina as characterizing Charcas, and referred by him tentatively to inclusions of troilite. An examination of the dots in Rodeo shows them to be minute, shallow, saucer-shaped pits. They are scattered irregularly along the bands of kamacite and are to be seen in some of the swathing kamacite, but never in the plessite. The tendency of the iron to rust at these points is greater also than at others. They appear, therefore, to mark the occurrence of some more soluble ingredient in the kamacite. The lamellæ of the meteorite may be grouped into two classes, one about a millimeter in width, swollen, and with wavy outlines, and the other about half as wide, and with more nearly rectilinear outlines. As a rule these two kinds of lamellæ have a different orientation as compared with each other. The kamacite is granular, much lighter in color than the plessite. A considerable quantity of swathing kamacite is present. While in general it follows the outline of the inclusions and forms a narrow border to them, at times its outer border is quite independent of the shape of the inclusions and it covers relatively broad areas. The tænite is well developed, silver-white in color, and displays the color of a section brilliantly on holding one at an angle to the light. The plessite is not depressed by etching as is the kamacite. At times it occupies the meshes alone, while again the meshes may display elaborate combs resulting from skeleton growths of tænite. Scattered irregularly through the sections and forming an important feature in the structure of the meteorite, occur numerous inclusions of schreibersite. The form of these inclusions, especially those of large size, is in general elongated, and rectangular and spindle-shaped. Some of the smaller inclusions, however, are star-shaped, while others have no well-defined form. The largest inclusion noted has a length of 1.5 inches (4 cm.) and a width of 0.25 inch (0.5 cm.). The schreibersite is tin-white in color, brittle, and magnetic, and affords the usual blowpipe and chemical tests for that mineral. The inclusions are always bordered by a band of swathing kamacite about 1.5 mm. in width. The inclusions, while having no apparent regularity of arrangement among themselves, are usually disposed, especially the elongated ones, parallel to the Widmanstätten figures; or in other words, the octahedral structure of the meteorite. Another inclusion of an interesting character found in one of the sections was a nodule about 1 cm. in diameter, of a black, amorphous, friable substance, resembling graphite. The form of the nodule in the direction of the section is nearly circular, but in the third dimension its extent is unknown, as it penetrates into the main body of the meteorite, which has not yet been cut. No band of swathing kamacite surrounds the nodule, it being set bodily into the mass of the iron. In appearance and physical properties the substance of the nodule resembles graphite fully, but it is magnetic and fuses in the reducing flame at about 4. Mixed with potassium nitrate it deflagrates readily, but throws out incandescent sparks in addition to the flaming usual to graphite. Potassim carbonate results from the reaction. Oxidation with sulphuric and chromic acids according to the French method affords an appreciable quantity of CO_2. On heating in oxygen the substance glows and becomes of a red-brown color. It was found to be little, if any, attacked by ordinary acids. After a long treatment with aqua regia, however, and addition of ammonia to the solution, a slight precipitate of iron hydroxide was obtained. When powdered and added to a copper sulphate solution, copper was reduced by the substance. Its specific gravity (obtained by Thoulet's solution) was 2.38. On account of the above properties it would appear that the substance is chiefly graphite, but contains in addition some form of iron, probably a carbide, intimately mixed with it. Such a mixture should exhibit the properties of magnetism, reductions from copper sulphate, and insolubility in acids, which are possessed by this substance. Such properties seem not to have been possessed by graphite which has been described from other meteorites. * * *

An analysis of the meteorite was made by Mr. H. W. Nichols. Material for analysis was secured by drilling a half-inch hole to a depth of seven-eighths of an inch, and rejecting the drillings from the crust portion. The analysis gave the following results:

Fe	Ni	Co	Cu	P	S	C	
89.84	8.79	0.28	0.07	0.80	0.02	0.09	=99.89

The composition of the meteorite is thus seen to be that usual to medim octahedrites, with a high percentage of phosphorus. From the large amount of schreibersite visible in the sections, such a content of phosphorus would be expected.

* * * * * * *

Cohen,[3] apparently without knowledge of Farrington's account, gave the following:

This meteorite was first mentioned by Ward in 1904 in his catalogue; data concerning the circumstances of discovery, form, weight, etc., are lacking as yet. According to a brief note from Ward the lamellæ are bent in places where there is a pitting of the surface and the bending follows the form of the pit. The usually short bands are straight, puffy, frequently considerably grouped, not granular, and with very strongly marked tænite edges. The numerous but always somewhat inconspicuous fields are quite small; they attain a size of 13 sq. mm. only in very exceptional cases. The kamacite appears under the magnifying glass to be uniformly fine-grained; under the microscope it appears to consist of sharply-defined grains of very various and irregular forms, attaining on the one hand a size of 0.05 mm. and on the other hand falling to greater fineness, and the larger number of them showing at the same time a brilliant, oriented luster. Under a much higher power there appears between these portions, dull black iron in the form of a very fine vein, and it seems as if each grain was itself composed of tiny granules. Most of the fields are composed of dense, dark plessite, which in the case of the smaller ones uniformly fills the entire field; in the case of the larger, only a small border band is so dark, while the interior, because of a shading in color, appears brighter, owing to the presence of tolerably large, evenly inlaid shiny scales. Then follow a few fields which consist of the same kamacite as the principal bands, and which are filled with combs, which as a rule run out only from two adjacent sides; thereby arises a similarity with such fields as consist of small entire lamellæ, in which case, however, each small band lies in its own tænite pouch. Occasionally a field shows partly the one partly the other formation.

Schreibersite occurs abundantly and in considerable size. The crystals are sometimes hieroglyphic in form and as much as 2 cm. in size, sometimes they are small and elongated and then attain a length of 4 cm. and a thickness of 2 mm. Compact isometric individuals also occur in isolation. The swathing kamacite is entirely like the kamacite of the lamellæ. Troilite was wanting entirely in a plate 250 cm. square. Magnetite occurs occasionally as a filling of crevices quite deep in the interior.

Bella Roca and Rodeo seem quite similar, but are distinguished by more thorough study, on the one hand because of the formation of the kamacite, which, in the case of Bella Roca even upon very great enlargement, still remains exceptionally fine-grained, and on the other hand by the occurrence of combs in Rodeo.

Analysis by Dr. O. Burger:

Fe	Ni	Co	Cu	Cr	P	S	Residue	
86.95	11.27	1.20	0.01	0.03	0.25	0.01	0.07	=99.79

The meteorite is chiefly preserved in the Field Museum.

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Rogue River Mountains. See Port Orford.

ROSARIO.

Northern Honduras, Central America.
Latitude 14° 40′ N., longitude 88° 45′ W.
Iron. Coarse octahedrite (Og), of Brezina.
Known 1895; undescribed.
Weight, ?

This meteorite is mentioned in Berwerth's [1] and Ward's [2] catalogues, and in Ward's catalogue it is stated that the main mass is in the Bement collection, undescribed. No further information at present is available regarding the meteorite. The piece in the Bement collection, now in the American Museum of Natural History, weighs 1,567 grams.

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RUFFS MOUNTAIN.

Lexington County, South Carolina.
Latitude 34° 16′ N., longitude 81° 25′ W.
Iron. Medium octahedrite (Om), of Brezina; Caillite (type 18), of Meunier.
Found 1844; described 1850.
Weight, 53 kgs. (117 lbs.).

The first account of this iron was by Shepard,[1] as follows:

We owe the discovery of the present highly interesting iron mass to Dr. Thomas Wells. From several communications with which I have been favored from this gentleman, I learn that he has but recently come into possession of the mass, and that he is still unacquainted with the particulars of its discovery. It would appear, however, that it had been until very recently lying in a neglected state, near the house of a farmer in the vicinity of the spot where it was first found.

The figure is irregular and ovoidal, being truncate at both extremities. Its greatest length is 31.5 inches, while its breadth is 29.75 inches. It weighed 117 pounds. Judging from the specimen I have seen, it would appear that the mass was coated with a black crust, thicker than is usual in these bodies; and accordingly the specific gravity varies somewhat, as the fragments by which it was determined comprehended more or less of the coating. Two of these gave 5.97 and 6.80, while portions seemingly free from the oxidated crust have 7.01 and 7.10.

I found the following composition in a specimen of very clean turnings, obtained in making a division of the mass by Doctor Wells:

Iron	96.000
Nickel	3.121
Chromium, sulphur, cobalt, and magnesium	traces
	99.121

The etched surface upon a large slab of the mass, which has been forwarded for the inspection of the meeting by Doctor Wells, shows it to be highly crystalline throughout, to belong to my sections of closely crystalline, alloyed, homogeneous, malleable irons. It exhibits an etched pattern which, on the whole, more nearly resembles those of the Texas, and the Carthage, Tennessee, meteoric iron; although it presents peculiarities distinguishing it from those, and from every other iron I have yet seen. It has, for instance, over much of its surface the rather broad raised spaces situated between the sharp raised lines (which spaces are usually dull and black), completely filled with closely aggregated shining polygonal areas, resembling the top figures at the extremities of basaltic columns. A few narrow gashes, each about 1 inch long, of a brilliant pinchbeck red pyrites appear near one extremity of the slab. The peculiar color of this sulphuret, and the manner in which it resists the action of acids, lead to the suspicion that it may prove to be an hitherto unobserved species.

The present, therefore, is the second well-authenticated discovery of meteoric iron within the State of South Carolina; and both masses have been brought to light within the space of a single year. The other mass referred to is that of Chester district, of which I presented a brief notice in the American Journal of Science soon after the discovery was made. A fuller account of the same is reserved for a future occasion. Suffice it to remark here, that there is no such resemblance between the two as to evince that they came from the same meteor, although they evidently belong to the same section and order of meteoric irons.

A later note on the probable date of fall was given by Shepard [2] as follows:

This highly interesting mass (weight 117 pounds), first brought into notice by Dr. Thomas Wells, and described by me at the Charleston meeting of this association, appears to have been one of very recent date. It was brought to the office of Doctor Wells, in Columbia, in the winter of 1844, with the account that it was incidentally met with by a person out upon a hunting excursion in a somewhat unfrequented place; the position of the mass being that of entire isolation, upon a flat surface of rock. This circumstance, coupled with the fact that the exterior is fresh on all sides and perfectly clean from the hydrated peroxide of iron, seems to justify the inference that it could not have occupied this situation for any length of time; the more especially when it is observed that freshly cut portions are prone to oxidation, even when carefully protected from air and moisture.

Under the title "Potassium in the meteoric iron of Ruffs Mountain, South Carolina," Shepard [3] recounted an experiment with the iron as follows:

This iron, it should here be mentioned, was not found on that part of the mountain situated in Newberry, as formerly supposed, but in the contiguous county of Lexington. Having noticed a peculiarity in the manner in which this iron acquires rust, even when kept in a dry air, I suspected that it proceeded in part from the oxidation of potassium. The broad flat face of the 56-pound mass figured rusts upon one margin to the depth of nearly 2 inches, and at times obviously gathers moisture, while the rest of the surface retains its dryness and polish. (The mass measures 8.75 inches in height and 7.5 inches horizontally across the polished face.) Turmeric paper applied to the moistened spots was immediately browned. This led me to subject 2 ounces of the rusted turnings of the iron, obtained in making sections of the mass, to a heat of near redness in a double crucible for half an hour, and to test

the water boiled upon it with reddened litmus and turmeric. It gave an alkaline reaction in both instances, which under the circumstances sufficiently proves that a fixed alkali was present. The deliquescence observed renders it probable that it was owing to the carbonate of potassa, rather than to the carbonate of soda, although there is nothing to disprove the presence of the latter alkali also. The condition in which potassium is present is of course only conjectural. It probably exists as an alloy with some of the other metals, which is not uniformly distributed throughout the mass. Indeed, the artisan who superintended the division of the iron informed me that he detected a marked difference in the softness and malleability of the metal in particular portions of the mass.

Rammelsberg [6] gave a determination of nickel in filings from the iron. In those dissolved in hydrochloric acid he found 7.6 per cent Ni, in those dissolved in chloride of mercury he found 9.65 per cent Ni. The mean amount of Ni he gives as 8.62 per cent.

Brezina [7] gave a positive and negative figure of an etched plate of the iron, showing Reichenbach lamellæ, and remarked:

Widmannstätten figures of medium width; metallic sheen; schreibersite abundant in the band iron and accompanying the Reichenbach lamellæ. A lamella 17 mm. long is accompanied by much schreibersite, and is partially inclosed by kamacite.

Brezina,[8] in 1885, classified the meteorite in the Caille group, and remarked concerning it as follows:

Ruffs Mountain is a very distinguished iron. The kamacite is quite spotted and granular, the borders of the grains forming at the same time the borders of the spots (in the majority of cases). Tænite is subordinate; schreibersite is present as ribs in the kamacite; troilite occurs as Reichenbach lamellæ and as nodules, the latter quite dark gray, apparently from the presence of graphite in abundance. Laminæ 0.85 mm. wide.

Meunier [10] classified the iron as caillite, and remarked concerning it as follows:

This iron is slightly remote from the type, but only in secondary characteristics. The kamacite occurs in very elongated bands, and is often more or less bent. Plessite is very abundant and the tænite constitutes, between the other two alloys, single continuous bands.

Brezina,[11] in 1895, gave a cut showing the etching figures of the iron and described, as follows, a section through the entire mass acquired from the Kunz collection:

Bands long, straight, little grouped, puffy; tænite well developed; fields predominating, filled with a mixture of plessite and tænite which resembles kamacite, the tænite mostly in the form of scattered particles. The kamacite and fields are very much spotted, especially on the fresh interior of the section, while the slightly attacked borders are dull for a depth of about 1 to 2 cm.; grains and ribs of cohenite are abundant in the kamacite. Reichenbach lamellæ are abundant; there is also a lenticular appearance of gray troilite. In the Siemaschko collection there is a specimen labeled Seneca Falls, and weighing about 15 grams, which doubtless belongs to Ruffs Mountain. It shows the bands straight, grouped, somewhat puffy; kamacite much spotted, somewhat granular; cohenite loose and occuring as ribs in the kamacite; fields full of combs and much spotted like the kamacite.

Cohen [12] found the iron not capable of acquiring magnetism.

The principal mass of this meteorite is in the Amherst collection (54 pounds), the remainder (11,300 grams) is distributed.

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RUSHVILLE.

Franklin County, Indiana.
Here also Brookville.
Latitude 39° 35′ N., longitude 85° 25′ W.
Stone. Gray chondrite, brecciated (Cgb), of Brezina.
Found 1866.
Weight ?

The first mention of this meteorite is made in Wülfing's catalogue [1] under the name Brookville. Ward [2] states that the meteorite is undescribed.

The main mass was acquired by Bement and is now in the American Museum of Natural History, New York City.

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RUSSEL GULCH.

Gilpin County, Colorado.
Here also "The Colorado meteorite."
Latitude 39° 45′ N., longitude 105° 40′ W.
Iron. Fine octahedrite (Of), of Brezina; Caillite (type 18), of Meunier.
Found 1863; described 1866.
Weight, 13 kgs. (29 lbs.).

The first description of this meteorite was by Smith [1] as follows:

I have known of the existence of a new meteoric iron from Russel Gulch in Colorado, for about two years, but it was only recently that it passed into my hands. I first heard of it in the possession of Mr. Fisher, of New York, who subsequently turned it over to Prof. C. F. Chandler, of Columbia College, New York, who kindly submitted it to me, as I am furnished with the necessary means for cutting up and scrutinizing thoroughly this class of bodies.

The mass of iron is accompanied with the following label: "Meteoric iron found in Russel Gulch, February 18, 1863, by Mr. Otho Curtice. Weight, 29 pounds. Brought to New York, February, 1864."

The mass measures in its extreme length, breadth, and thickness 8.5 by 7.25 by 5.5 inches. It is perfect in all parts except at one extremity, and, as stated above, weighs 29 pounds.

This iron is one of medium hardness, with a density 7.72, and when cut through was found to contain a few small nodules of iron pyrites. It is attacked readily by nitric acid, and gives bold Widmannstätten figures without very sharp angles. It resists the action of air and moisture very well, and is consequently but little altered on the surface. No siliceous minerals could be traced in any of the crevices. On analysis its composition was found to be—

Iron	90.61
Nickel	7.84
Cobalt	.78
Copper	minute quantity
Phosphorus	.02
	99.25

Brezina [2] remarked regarding the Vienna specimen as follows:

There are two entirely different specimens in the Vienna Museum labeled Russel Gulch. The principal one, obtained from Lawrence Smith, is undoubtedly authentic; another one comes from the Calcutta collection and belongs to the Trenton group of medium octahedrites. The authentic one is entirely different from the four other specimens of Brezina's class Ofch, on account of the almost entire absence of ridges or the perfect uniformity of the bands.

Meunier [4] stated:

This iron is a typical caillite and especially analogous to Kenton County, that is, with excess of kamacite. The tænite and the kamacite are normal. Inclusions, more or less irregular in form, are numerous; no pyrrhotine is visible; but schreibersite is not wanting.

Cohen [5] described the structure as follows:

The somewhat bunched lamellæ are long and, according to Brezina, 0.15 mm. broad and usually bent, although in very irregular manner and degree; the curvature is considerable. In the illustration of a section the bending is exceptionally small and is wanting entirely in most of the lamellæ. Tænite appears distinctly upon some sections, very sparingly upon others. The large and abundant fields are somewhat less prominent than the bands.

The kamacite is much broken up into grains by meandering, fine crevices and appears at the same time to be striped and flecked, causing a peculiar fibrous appearance and dull silken sheen. The stripes are not due to hatching, as was formerly supposed, since under a very strong magnifying power numerous black, pointlike inclusions become visible, and their irregular distribution causes the flecked and striped appearance. Only a few tiny fields, scarcely visible to the naked eye, consist of compact, dull dark plessite. The rest are composed of bands 0.05 to 0.2 mm. thick of varying and irregular form which, under the microscope, resemble the principal lamellæ. Those under consideration are distinguished from similar areas in other meteoric irons by the fact that the bands are in immediate contact with one another and no trace of tænite seams or inclosed compact plessite is discernible. In rare instances the tænite sends forth from the extreme edge thorny processes into the area, or there appear in the interior a few isolated, glistening scales which may be taken for tænite or schreibersite. Schreibersite occurs sparingly in rounded crystals enveloped in kamacite, then comes troilite in isolated grains up to 1 cm. in size, and iron-glass in small dark specks.

Russel Gulch is characterized by a marked and manifold bending of most of the lamellæ, a dull, silken luster, and the almost identical appearance of the bands and fields. An etched surface, therefore, has an unusually peculiar appearance and very distinctly marked, as in the case of La Grange.

Analysis by O. Burger:

Fe	Ni	Co	Cu	Cr	S	P	
92.34	7.43	0.66	0.04	0.01	trace	0.13	=100.61

The meteorite is distributed, but the largest quantity (11.25 pounds) is in the possession of the American Museum of Natural History.[6]

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Rutherford County, 1847. See Murfreesboro.

Rutherford County, 1880. See Colfax.

SACRAMENTO MOUNTAINS.

Eddy County, New Mexico.
Here also Badger.
Latitude 32° 55′ N., longitude 104° 40′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1896.
Weight, 237 kgs. (523 lbs.).

This meteorite was described by Foote [1] as follows:

On nearing Fort Stanton, Arizona Territory, while on a westward journey in 1876, Mr. M. Bartlett of Florence, Arizona Territory, saw a meteor pass through the heavens in a southerly direction and fall, with a report like that of a cannon, on the east side of the Sacramento Mountains.

The above account was given by Mr. Bartlett to Mr. C. R. Biederman, and to the latter gentleman is due the credit of securing the specimen to science and furnishing the historical data here given.

Continued inquiry in the Pecos country was fruitless until by chance a small sample of native iron was presented to Mr. Biederman, for assay, and proving to be meteoric, led to the locating of the mass through the first finder, a shepherd, named Beckett.

The latter, in a sworn statement, says that he found it while herding in the lower foothills of the Sacramento Mountains, Eddy County, New Mexico, about 23 miles southwest of a place called Badger. It rested on top of a limestone hill, where it had made a depression, and was partly buried. He could find no other pieces. Mr. Biederman, heading a search party, found the mass at the place indicated, and with much labor dragged it 6 miles over the desert to a wagon road. A long search was made by the party, but nothing else could be found. It is complete, save for about 500 grams of fragments, broken off by Beckett, and a piece of 1,500 grams sawed off after it came into the possession of the firm of Dr. A. E. Foote. Its appearance indicates that no rupture occurred through an explosion during its flight nor by the force of the fall. The small fragments mentioned were employed in analysis and the making of a knife.

It is a typical example of the class of siderites, weighing complete about 237 kgs., with general dimensions of about 80 by 60 by 20 cm. The exterior exhibits in a splended manner the characteristic markings of meteoric iron. On the flat side, shown in a plate, are two cup-shaped pits of 10 to 12 cm. diameter which constitute a remarkable feature; the smaller depressions or "thumb-marks" of 3 to 4 cm. diameter, which cover the remainder of the surface, are also reproduced in minute detail.

At the point where the fragments were removed the octahedral cleavage and lines of crystallization are noticeable to a degree rarely seen in iron. It is, however, on the etched surface prepared through treating a polished slab with dilute nitric acid, in the usual manner, that the beauty of the crystalline structure is best seen. In this respect it ranks among the finest of recorded irons, the Widmannstätten figures being exceptionally regular and distinct. An accompanying print was made directly from the etched surface. The broad bands of kamacite are symmetrical, the prominence of the interlacing of shining white threads of the nickeliferous iron being especially remarkable, and distinguishing it from the El Capitan meteoric iron, weighing about 28 kgs., and found in 1893 about 90 miles north of the Sacramento Range. In the latter iron the percentage of iron is less and nickel greater, phosphorus also being present. For a careful quantitative analysis the writer is indebted to Mr. J. Edward Whitfield (with Booth, Garrett & Blair, of Philadelphia), who obtained the following results:

Iron	91.39
Nickel	7.86
Cobalt	.52
	99.77

The mass is perfectly preserved, there being no sign of disintegration or exudation of lawrencite. The sawing done shows it to be quite soft and generally homogeneous. The entire lack of surface alteration proves that it fell at a comparatively recent date and leads to the conclusion that it is the meteor seen to fall by Mr. Bartlett, whose account led to the discovery.

The meteorite is distributed.

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Saint Croix River. See Hammond.

Saint Elizabeth. See Lucky Hill.

SAINT FRANCOIS COUNTY.

Missouri.
Here also Southeastern Missouri.
Latitude 37° 49′ N., longitude 89° 55′ W.
Iron. Coarse octahedrite (Og), of Brezina; Arvaïte (type 7), of Meunier.
Described 1869.
Weight, 2,418 grams (5 lbs.).

This iron was first described by Shepard [1] as follows:

For my knowledge of this iron I am indebted to Prof. B. F. Shumard, of St. Louis, who sent me a specimen of it several years ago, but through an accident it failed to reach me until lately. He wrote me under date of November 4, 1868, as follows: "The specimen is from one in the collection of the St. Louis Academy of Sciences, which I found among minerals that belonged to the old Western Academy of Sciences of St. Louis. The label with it gives only 'S. E. Missouri' as the locality. Its meteoric character was unknown until I examined it." In reply to my request for further information Professor Shumard has favored me (December 18) with the following additional particulars:

"The specimen in the Academy's collection is irregularly lozenge-shaped, 3.3 inches long, 1.5 wide, and 1.1 inches thick. The extremities and upper face are rough and irregular, one lateral piece is smooth with a wavy surface, the other has been cut to supply specimens to Professors Silliman, Haidinger, and yourself.

"The under side is rough near one end, while the remainder of it has been smoothed by hammering. The specimen bears the appearance of having been heated. Its present weight is 9 ounces, and if you will add to this what has been taken to furnish the specimens referred to above you will probably not be far from the truth in calling the original weight 12 ounces. Nothing has been published concerning the specimen. I discovered it in the museum of the academy during the year 1863."

In respect to the figures developed by etching it belongs to my order of megagrammic irons, and most resembles those of Arva and Cocke County. It is rich in schreibersite, insomuch that when long exposed to acid, this mineral projects in thick laminæ above the surface, resembling mica on certain weathered coarse-grained granites. The bars and spaces which are intermediate, however, are not traversed by those delicate lines of the same substance, so generally occuring in other irons.

Specific gravity, 7.015 to 7.112. It appears to contain no chlorine. It gave—

Fe	92.096
Ni	2.604
Schreibersite	5.000
Cr, Co, Mg, and P	traces
Residue of Fe_2O_3, $Si O_2$, and C.	
	99.700

Brezina,[3] in 1885, grouped the meteorite in the Arva group, and remarked that it resembled Wichita, since it showed hatching.

Meunier [4] classed the meteorite as arvaite. He remarked concerning it as follows:

The museum possesses only a small specimen of the meteoric iron found in 1863 in the southeastern part of the State of Missouri, but the specimen suffices to show the identity of its substance with that which forms arvaite.

The schreibersite is much less abundant than in the Sarepta iron, but it has in the main the same disposition and the same characteristic kamacite bands of the arvaite type. Pyrrhotine is visible here and there, and in its neighborhood are found graphitic lamellæ which complete the resemblance to the type.

Cohen [5] remarked that cohenite was probably present in the meteorite. He gives the name St. Francois County as a synonym of southeast Missouri.

Brezina,[6] in 1895, also used the name St. Francois County with southeast Missouri as a synonym, but does not give the origin of the name St. Francois County. He states that a plate was acquired which gives a complete section through the iron. He says:

It shows a regular structure. The lamellæ are long, straight, grouped, but slightly puffy. Tænite is very scarce, field subordinate, very like the bands; ribs of cohenite quite numerous in the kamacite in the form of individual grains; kamacite very uniformly grouped.

Wülfing [7] grouped St. Francois County and southeast Missouri together, quoting Cohen and Brezina. He notes a total weight of 2,418 grams.

Cohen [8] made a study of the meteorite as follows:

Although Shumard gives the weight of the original southeastern Missouri at 340 grams, Bement, Ward, and Vienna possess 2 kgs. of St. Francois County, so that a second larger piece must have been found later, which under the name of St. Francois County, as it seems given by Kunz, was brought into commerce without a notice of it having been made in literature. A brief note from Brezina informs me that the pieces of St. Francois County, in Vienna, were obtained through Kunz from the Bement collection and correspond completely with the older southeastern Missouri. Two pieces were placed in my hands for investigation of the structure; one from the Vienna Museum weighing 288 grams and the second from the Griefswald collection weighing 30 grams. The following points may be noticed in addition to the characteristics stated by Brezina: Besides some few fields made up of little kamacite rods and intercalated tænite foliæ occur portions of a field-like appearance which, however, consist of short puffy lamellæ with etched lines running in a single direction. They are evidently what Brezina designated as bands resembling fields. It may be questioned whether such portions should be referred to fields. They may be kamacite individuals in which occur short combs which are intergrowths of the bordering tænite, which is not the case in the normal bands. As was shown by Brezina, and as is usual in coarse octahedrites, the fields of St. Francois County are subordinate. The troilite mentioned by Ward and Meunier is lacking in my sections, also the graphite-like lamellæ mentioned by Meunier. The distribution of these accessory constituents is evidently thus very unequal. On the other hand, the ribs of cohenite mentioned by Brezina occur in the bands in the form of grains and small prisms 7 mm. long and .6 mm. broad; also large schreibersites which do not, like the former, lie with their principal direction parallel to the bands. In the immediate neighborhood of the largest schreibersite occurs a zone 4 to 6 mm. broad of granular kamacite, the size of the grains rising to 1.5 mm. Since granular kamacite does not occur elsewhere, the schreibersite has probably influenced the crystallization of the nickel iron. The cohenite ribs are smaller and more sparingly present than are the crystals composed directly of cohenite in Magura, Beaconsfield, Bendego, and related irons. Most of the bands lack them entirely. Rhabdite occurs in crystals from 0.003 to 0.04 mm. thick. It can not be directly observed, but remains behind on dissolving pieces in dilute acid. Where the plates have a natural surface, black, hard portions extend into the nickel iron which resemble the so-called iron glass. A piece weighing 14.082 grams was analyzed by Fahrenhorst, with the following result:

H_2O	12.28
Fe_2O_3	93.52
NiO+CoO	7.76
	113.56

This shows a mixture of iron hydroxide with nickel iron, and indicates a rust crust which has penetrated by clefts into the nickel iron.

The analysis of the meteorite gave:

Fe	Ni	Co	Cu	Cr	Cl	S	P	Silicate	
92.68	6.97	0.52	0.02	0.00	0.03	0.01	0.34	0.01	=100.58

This indicates the following mineralogical composition:

Nickel iron	97.71
Schreibersite	2.20
Troilite	0.03
Lawrencite	0.05
Silicate grains	0.01
	100.

On solution in aqua regia only a slight residue of silicate grains was left. The brown flocculent residue usual where cohenite is present was lacking altogether so that in the piece analyzed no cohenite was probably present.

The specific gravity was determined by Leick at 7.7460 at 16° centigrade on a piece weighing 270 grams. This gives, with the removal of the accessory constituents, 7.7728 as the specific gravity of the nickel-iron. In order to determine whether the cohenite was absent only from the piece used for analysis (which did not contain large crystals) or whether the crystals appearing like cohenite were in fact all schreibersite, a larger piece weighing 9.1 grams relatively rich in the constituent was dissolved. This showed much more resistance to attack by hydrochloric acid than any meteoric iron I have ever seen. A mixture of one part acid and one part water had finally to be employed, but even then the solution went on slowly. Besides 0.21 per cent of tænite and 0.48 per cent of some angular pieces, schreibersite with some rhabdite was observed, amounting together to 3.18 per cent. In addition there was 0.15 per cent calculated from the phosphorus contained in the solution. This shows that shcreibersite occurs, like cohenite, imbedded in kamacite; and also, what I have often declared, that these two minerals can not be distinguished without a careful study of isolated crystals.

The meteorite is distributed. Ward possesses 753 grams; Vienna 641 grams.

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SAINT GENEVIEVE COUNTY.

Missouri.
Latitude 37° 47′ N., longitude 100° 20′ W.
Iron. Fine octahedrite (Of) of Brezina.
Found, 1888.
Weight, 244½ kgs. (539 lbs).

This meteorite was first described by Ward,[1] as follows:

This iron was discovered in the autumn of 1888 in the extreme western portion of St. Genevieve County, Missouri, at a point about 1 mile west of Punjaub, a little hamlet no longer existing. We have decided in the lack of closer possible location to give it the name of the county, whose county seat of the same name lies some 15 miles to the eastward.

It was found by Mr. Zeb Murphy, a surveyor, who retained it in his possession for several years, showing it at county fairs, etc. It was subsequently bought from Mr. Murphy by Mr. F. P. Graves, the secretary and assistant superintendent of the Doe Run Lead Company, whose headquarters are in the town of Doe Run, Missouri. Mr. Graves has been a life-long collector of the minerals in this part of Missouri, and this St. Genevieve meteorite has been for some years past a crowning piece in his fine cabinet. From him it was obtained by the present writer in January, 1900.

The shape of the St. Genevieve siderite is an elongated spheroid, considerably flattened upon one side with a rudely crescent-shaped, shallow depression in the middle part. Its greatest length is 20 inches, its two other dimensions are each 15.5 inches. Its weight when I first obtained it, before any part had been cut from it, was 539 pounds.

The exterior of the mass shows no sharp distinct pittings, although having several shallow depressions that appear to have been prior to the oxidation which has largely covered the surface and which has quite destroyed any trace of outer crust or skin, if such ever existed.

The present color of the mass is a dull reddish brown, with patches of brighter iron showing here and there. By slicing the mass into a number of sections, the surfaces of which are about 1 foot by 1 foot, 4 inches in diameter, there were revealed troilite nodules, few in number and of small size (from 4 to 9 mm. in diameter), but which lacked the border of schreibersite that so prominently surrounds these nodules in the majority of irons.

The Widmannstätten figures are brought out by etching sharp and clear, and are of very even size and character throughout the entire mass. They are typically octahedral. On the numerous plessite patches the alternating tænite and kamacite blades (Laphamite markings) are well developed, the tænite standing out prominently in relief. The chemical composition of this meteorite has been determined by J. Edward Whitfield. His analysis is as follows:

Fe	Ni	Co	Si	P	O	C		Specific gravity
91.58	7.98	0.29	0.023	0.20	trace	none	=100.073	7.756

The main part of this great mass, weighing 106.56 kgs., has taken its final position in the Ward-Coonley Meteorite Collection now on deposit in the American Museum of Natural History, New York City.

Cohen [2] described the structure of the iron as follows:

In the sections before me the lamellæ are long, straight, much granulated, slightly puffy, and seldom, and then only, slightly bunched, tænite borders slightly prominent, fields subordinate and indistinct. The kamacite has a twofold structure. In one portion of the bands it shows distinct and sharp hatching and a few etching pits; the oriented luster is lively, and the isolated, unusually large etching pits attain a diameter of 0.015 mm.; then, upon greater enlargement, there often appears an irregular dark veining, which I consider to be etching rills. In other bands the pittings and questionable etching grooves are more numerous, and there also appear black dustlike particles which finally, especially in the central portion, hold the field alone. The bands are dull and dark colored, but under the microscope brighter line systems are visible, which seem to be half-covered etching lines. Frequently there is a smaller border of this second group composed of bright and glistening bands, since there are no dark inclusions and only isolated pittings here. The plessite is composed of small lamellæ of exceedingly various and irregular forms. These show the same structure as the principal lamellæ; that is, they are very granular and are in places free from the above-mentioned dustlike inclusions, while again some places are filled with them, indeed, these occasionally increase to such an extent that the entire field seems comparatively dark, except for a few small, isolated shiny places. Minor constituents were wanting entirely from the sections examined.

Characteristic for St. Genevieve is the alternation of dull and brightly glistening bands, plessite corresponding with these bands and therefore but slightly prominent, and the occasionally smooth outer zone of kamacite, which lends to the etching surface, in certain positions with reference to direct light, an irregular appearance. Not all of these phenomena appear with equal distinctness upon all section surfaces.

The principal portion of the meteorite is in the Ward-Coonley collection.

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Salem. See Smithland.

SALINE.

Saline township, Sheridan County, Kansas.
Latitude 39° 22′ N., longitude 100° 29′ W.
Stone. Crystalline spherulitic chondrite (Cck) of Brezina.
Fell 9.30 p. m., November 15, 1898; found, fall of 1901; described, 1902.
Weight, 31 kgs. (68 lbs.)

This meteorite was first described by Farrington,[1] as follows:

The Field Columbian Museum has recently received a meteorite seen to fall in Saline township, Sheridan County, Kansas. The chief observer of the fall was Mr. S. A. Sutton, of Hoxie, Kansas, and he was also the finder of the mass. The fall took place November 15, 1898, at about 9.30 p. m., the circumstances being thus described by Mr. Sutton: On the date mentioned he was about to retire for the night when a great light seemed to flash in his house accompanied by a rushing noise. He supposed a large lamp in an adjoining room was exploding, but on hurrying to the room saw instead a great fiery mass passing the window near him. Its path was nearly horizontal and the direction of motion northwesterly. The light given off was white and intense like that of an electric light, and a fiery trail several hundred feet long with sparks of various colors followed in its wake. The whole made a beautiful as well as awe-inspiring spectacle. The light was so intense as to illuminate the entire house and was noticed by other members of the family besides Mr. Sutton.

Whether it was noticed by others in the region has not been positively ascertained as yet, but as the territory is sparsely populated it may be that no other observer will be found.

Mr. Sutton, being a surveyor by profession, at once began to form as accurate estimates as possible of the speed, direction of motion, etc., of the mass, in order to enable him to discover where it would be likely to strike the earth. The speed he estimated at 1 mile per second, the angle with the horizon as 25° and that with the meridian as 20° west of north. These estimates led him to conclude that the point of fall would be about 4 miles from his home, but all subsequent searching in that region proved futile. At the end of nearly three years, however, he made a recalculation in which he assigned a greater speed to the meteorite than he had before done. This indicated that the point of fall might have been about 8 miles away. Seeking in this locality his efforts were rewarded in the fall of 1901 by finding the meteorite in the bank of a "draw." It had penetrated the soil to an underlying limestone stratum on which it lay. The thickness of soil at the time of excavation was considerable, but this might have undergone considerable change since the fall of the meteorite. Great credit is certainly due Mr. Sutton for the skill and persistence with which he followed up his observations.

The mass as received at the museum has the form of an irregular, somewhat tabular polyhedron bounded by eight approximately plane surfaces. Its weight is 68 pounds 10 ounces. It is covered, except where a few small fragments have been broken off, with a thick black crust contrasting in color to the dark-gray hue of the interior. The crust is stippled with protruding metallic grains, for the most part coated with a black oxide of iron, but occasionally showing bright, and nickel white in color. One of these protruding grains reaches a diameter of 5 mm., the others are smaller. Cracks through the crust give the meteorite a "baked" appearance. There are numerous characteristic pittings, for the most part oval in shape and having a length of about 2 cm. A slight coating of carbonate of lime occurs in places over the surface, doubtless formed upon the meteorite while it lay in the soil, but aside from this the mass has a remarkably fresh and unoxidized appearance. The texture of the stone is quite firm and compact. Even to the naked eye a chondritic structure is apparent and chondri about 2 mm. in diameter can be broken out.

A brief chemical and microscopical examination shows the chief constituent minerals to be chrysolite, bronzite, and nickel-iron, a fuller account of which will be given in a future museum publication The specific gravity is 3.62. Having fallen in Saline township, this will be the name used for designating the meteorite. The region in which if fell is one which has already, within an area of 85 by 120 miles, yielded five and possibly six distinct finds of meteorites of such character that they must be considered separate falls. Now that an observed fall has taken place in the region, it would seem that some reason must be sought for the large number other than mere coincidence or the fact that the area is not forested. A further feature of interest in connection with the fall is the fact that it occurred at the time of the Leonid showers. Only two such instances have hitherto occurred within this period, these two being the falls of Werchne Tschirskaja and Trenzano. These are both veined spherical chondrites and the present indications are that Saline township belongs in the same category.

Later an account was given by the same author of the finding of free phosphorus in the meteorite as follows:

On drilling into the Saline Township meteorite recently for the purpose of breaking off a piece, a white "smoke" was observed by the writer to rise from the drill hole when a depth of a little over 2 inches (5.5 cm.) had been reached. This "smoke" had a pungent, garliclike odor which was recognized as similar to that of white phosphorus. It was more pungent and resembled the odor of burning arsenic to some extent, but on the whole suggested that of phosphorus more. It was at once surmised that phosphorus might exist in the free state in the meteorite, and the supposition was soon confirmed by the following tests:

1. On shielding the eyes from the light and looking into the drill hole, a luminous spot could plainly be seen at the bottom. This spot on further observation showed itself to be actually made up of two. One of these was fixed and central and the other moved around it, making a revolution every two or three seconds. This motion corresponded to the swirling movement with which the fumes rose from the hole and doubtless represented the manner of supply of air to fresh portions of the phosphorus.

2. On holding a strip of paper saturated with silver nitrate in the fumes it turned black in a few moments.

3. On treating some of the powder from the drilling with nitric acid and adding the solution so obtained to ammonium molybdate, the familiar yellow precipitate of ammonium-phospho-molybdate was produced.

The fumes continued to rise from the hole for about two hours, when they gradually diminished in volume and disappeared. The odor could, however, be detected 18 hours afterwards. These observations were confirmed by several of my associates. No effort has as yet been made to obtain a quantitative determination of free phosphorus in the meteorite, nor is it likely that results of any particular value could thus be gained. Two holes were drilled the same depth as the first in other parts of the stone, but from neither was any repetition of the above-named phenomena observed. The phosphorus is (or was) probably, therefore, only locally distributed and in small quantity. The stone where broken at the end of the hole first drilled shows a spot about half an inch in diameter differing considerably in color from the rest of the stone, being brownish white in contrast to the greenish-black hue of the remainder. This portion may prove on further examination, therefore, to be differently constituted. The properties above described are those of free phosphorus, however, and the observations leave no doubt that it existed in the meteorite. This seems to be the first known instance, then, of finding this element existing in the free state in nature.

Klein [3] remarked beautiful eccentrically radiated chondri of enstatite in the meteorite.

A further account of the meteorite was given by Farrington,[4] as follows:

Some further observations may here be added to the brief account of this meteorite given by the writer in 1902. The approximate place of find of the meteorite was kindly indicated to the writer by Mr. S. A. Sutton, and shown in a plate. No other observations of the fall than those already made by Mr. Sutton and reported by the writer seem to be known. The shape of the meteorite may be described as approximately that of a truncated, four-sided pyramid. The base of the pyramid was plainly the rear side of the meteorite in falling. It is the broadest surface of the mass, and has an area of about 144 square inches (900 sq. cm.). In outline it is roughly circular. Mr. Sutton states that this was the surface on which the meteorite rested when found, but this position could have been brought about by an overturn when striking. It was more heavily coated with carbonate of lime when received at the museum than any of the other surfaces. It is nearly flat, though slightly concave, and shows the broad, shallow pits characteristic of these surfaces of meteorites. On the opposite side of the meteorite a surface having the form of a long and narrow isosceles triangle runs nearly parallel to it and the thickness of the meteorite between the two surfaces ranges from 7 to 8 inches (18 to 20 cm.). From the parallel surface the meteorite slopes away at angles of 40°, 50°, 60°, and 90°, approximately. Three of these surfaces are approximately plane, the others are rounded. The plane surfaces show practically no pits, the others are more or less irregularly pitted. The more symmetrical of these pits are oval in form, from 0.5 to 0.75 inches in their longest diameter; and have a depth about one-fourth as great. All the edges produced by the meeting of different surfaces of the meteorite are rounded.

Except where it has scaled off in small areas the meteorite is covered with a firmly adherent, dull brown-black crust, rough from the protrusion of thickly scattered metallic grains. These grains are darker in color than the rest of the crust, probably from a coating of iron oxide. When this coating is scraped away, however, the bright nickel-white color of the metallic grains is seen. One of the grains showed bright when the meteorite was received, but it may perhaps have become so through handling. It is the largest single grain to be seen. It has a hemispherical form and a diameter of 5 mm. The shapes of the other metallic grains as they protrude are various. Some are elongated, some nearly circular, and others form small connecting groups. For the most part the grains are independent of each other, but there are two well-defined groups of them extending in irregular lines and standing out like veins. These are not straight in their course but nearly so. The extent of each is about 6 cm. (2.5 inches). One runs from the large grain mentioned above, the other is nearly parallel to it 7 inches (18 cm.) distant.

Besides being broken by the protrusion of the metallic grains, the crust is seamed and fissured by numerous cracks extending in all directions and varying in extent and depth. The largest has a length of 6 inches (15 cm.), and from this to the minutest fissures all gradations occur. The course of most of the cracks is straight toward the interior of the meteorite, but some run so as to tend to scale off. They give the exterior of the meteorite a "baked" look, and there can be little doubt that they are the result of differential expansion through heat of the interior as compared with the exterior. Scaling of the crust had occurred at various points when the mass reached the museum. Many of these scalings must, on account of their freshness, have occurred very shortly before the meteorite struck the earth or from the force of impact. Most of the surfaces thus exposed were covered with an adherent coating of carbonate of lime when the stone was received at the museum. The lime undoubtedly deposited more readily here on account of the increased capillary attraction afforded by such surfaces. The color of these surfaces was for the most part rusty brown from exposure, but a few were of a greenish-gray color where the carbonate of lime was freshly removed. In addition to these wholly uncrusted surfaces one about 3 inches square had a very thin black crust, much thinner than the average crust. It is evident that at this point a piece scaled off from the meteorite during its passage through the air and time sufficed for only a partial fusing of the freshly exposed surface.

Internally the substance of the meteorite when freshly broken is of a greenish-gray color and firmly coherent texture so that it takes a good polish. Enough weathering has taken place, however, to give the interior in large part a dark-brown color. The percentage of metallic grains seen on a polished surface is large, so as to seemingly constitute about one-fourth the mass. The metal is uniformly distributed but the grains vary in size and shape. Some having a diameter of 4–5 mm. are discernible. At times they aggregate into veinlike lines. Under the microscope all the striking characters of the spherical chondrites are presented by the meteorite. Chondri of great variety of size and structure make up the principal mass. For the most part the chondri are spherical in form but some are oval and others of unsymmetrical outline. Besides complete chondri, fragments of chondri are to be seen. As was stated in the writer's first paper on the meteorite, enstatite and olivine either singly or in combination chiefly compose the chondri. Diameters of from 0.3 to 0.6 mm. are presented as a rule by the enstatite chondri, but one 3 mm. in diameter was seen in one section. Several of the half-glassy chondri show rounded depressions as if made by the pressure of another chondrus. The olivine chondri are both monosomatic and polysomatic, also porphyritic and lamellar. In dimension they vary as widely as do the enstatite chondri and between about the same limits. The porphyritic individuals of the chondri show, as a rule, well-marked prismatic outlines. Crust sections under the microscope fail to show, except for an outer fusion zone, well-marked zones such as are common in the more porous chondrites. The fusion zone is of a dark, nearly opaque, somewhat blebby and glassy nature, and has a thickness of about 0.08 mm. Succeeding this, toward the interior of the meteorite, a zone about 0.4 mm. in thickness shows scattered opaque impregnations interspersed among unaltered olivine crystals. This zone is not uniform in occurrence, however, and can be seen only at intervals.

The meteorite is chiefly in the possession of the Field Museum.

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Saltillo. See Coahuila.

SALT LAKE CITY.

Between Echo and Salt Lake City, Utah.
Latitude 40° 48′ N., longitude 111° 36′ W.
Stone. Brecciated gray chondrite (Cgb) of Brezina.
Found, 1869; described 1886.
Weight, 875 grams (2 lbs).

This meteorite was described by Dana and Penfield [1] as follows:

In the summer of 1869 this meteoric stone now described was found by Mr. Clarence King in Utah, on the open prairie between Salt Lake City and Echo. It was given by Mr. King to Professor Brush and he presented it to the Yale College collection.

Nothing is known in regard to the circumstances or time of its fall; in that dry climate it may well have lain exposed on the surface of the ground for a long time without disintegration, especially as it was well protected by its crust.

Its weight is 875 grams; it is oblong in shape, about 12 cm. long, and 9 cm. in its greatest width; one edge is sharp and wedgelike, and one end is relatively sharp, the other rounded. The surface is comparatively smooth and shows only a few broad and shallow pittings. A uniform crust, smooth, except for minute angular elevations on certain portions and not very thick, covers it almost completely. The color of the crust is reddish black, in consequence of the partial rusting of the fused material. A small portion of the mass has been broken from one end to give material for study.

The interior of the stone is of a dark bluish-gray color, distinctly mottled by its chondritic character, and showing a rather large proportion of iron irregularly distributed through it, with minute patches of troilite. The small portions of the interior of the stone which had been exposed are much stained by the oxidation of iron, but this change has penetrated comparatively little into the mass, and the stone as a whole is exceptionally hard and firm.

The nature of the mineral substance which, together with the metallic parts, makes up the mass can be only imperfectly made out by mere microscopic examination; thin sections, however, under the microscope show this very satisfactorily. The olivine is the most prominent constituent. This appears frequently in spherules or "chondrules" of the size of very small shot; these are made up of a multitude of individual grains having a distinct rounded outline and each with its own optical orientation. These granular chondrules are sometimes inclosed by an iron border, and as the grains of olivine are fresh and clear and give brilliant polarization colors they form very beautiful objects under the microscope. The separate grains in these cases are closely packed together, but sometimes show a little intermediate glassy matter. The olivine also appears in relatively large fragments, much fractured, but showing by the common optical orientation that all belongs to a single individual. Still again the olivine is seen in chondri which have a distinct coarsely fibrous structure in consequence of the inclusions of dark-colored glass.

The bronzite (enstatite) appears in irregular crystal fragments scattered through the mass; also in chondri with fine fibrous structure usually eccentric. These have sharp angular outlines in many cases and appear to be but fragments of the original spherules; in this as in some other respects the stone has a marked brecciated character. To the bronzite also are to be referred occasional large spherules having a coarsely fibrous or columnar structure, the fibers lying in several directions within the limits of the same individual.

Plagioclase feldspar seems to be present in crystalline fragments, showing distinct, though not sharp, twinning structure. Especial interest attaches to this constituent of the stone because it shows most clearly the brecciated character just alluded to. One piece, for example, has been broken transversely a number of times and then cemented by the groundmass so that it still preserves in general its original outlines though made up of separate sections. This feldspar is rich in black inclusions lying parallel to the twinning lines. A number of patches of an isotropic mineral, which is probably to be referred to maskelynite, were also observed.

The specific gravity of this meteorite was found to be 3.66.

A careful chemical analysis by Penfield gave the following results. It was divided in the first place into the nickeliferous iron, 17.16 per cent, and the mineral part, including the troilite and silicates, 82.84 per cent.

The analysis of the iron yielded:

Fe	91.32
Ni	8.04
Co	0.60
Cu	0.04
	100.00

The mineral portion was divided into:

Soluble in HCl	Troilite Fe(Ni)S	6.70	(with NiS=0.62)
	Silicates	48.85	
Insoluble in HCl, including chromite		43.97	
Water		1.14	
		100.66	

The analyses of the soluble and insoluble portions gave further:

	Soluble in HCl.		*Insoluble in HCl.*	
SiO_2	19.70	40.33	24.11	54.83
Al_2O_3	0.25	0.51	2.12	4.82
FeO	10.42	21.33	3.80	8.64
MgO	17.17	35.15	10.80	24.56
CaO	0.81	1.66	1.47	3.34
Na_2O	0.16	0.33	0.87	1.98
K_2O	0.02	0.04	0.05	0.12
P_2O_5	0.32	0.65	.....	.....
Chromite	.....	.....	0.75	1.71
	48.85	100.00	43.97	100.00

Specific gravity, 3.66.

The molecular ratio of the silica to bases in the soluble portion is 1 : 1.72, so that besides the olivine the glassy portion is probably here included. The composition of the insoluble part implies that it is made up largely of bronzite with a little plagioclase. Among the stones in the Yale College collection that from Chantonnay seems to bear the closest resemblance to this new stone.

Brezina [2] classed the meteorite as a brecciated gray chondrite and remarked that this stone has many white chondri in a gray and white fine groundmass.

The meteorite is somewhat distributed, but the Yale collection possesses the largest amount, 834 grams.

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2. 1895: Brezina. Wiener Sammlung, p. 251.

SALT RIVER.

Twenty miles below Louisville, Kentucky.
Latitude 37° 58′ N.; longitude 85° 38′ W.
Iron. Finest octahedrite (Off) of Brezina; Braunite (type 3), of Meunier.
Found ?; described, 1850.
Weight, 4 kgs. (8 lbs.).

The first account of this meteorite was given by B. Silliman, jr.,[1] as follows:

This iron was found by Mr. Jacob Watters, of Louisville, on Salt River, a tributary of the Ohio, about 20 miles below Louisville, Kentucky. The mass which Professor Silliman exhibited weighed about 8 pounds when it came into his hands. It had been heated in a forge by its original proprietor, to remove a portion, and, in this process, the original form is somewhat defaced. Nothing is known of the time and of its fall. Iron of the same mass is said to be in the hands of some person whose name has not yet reached me.

The meteoric character of the mass is apparent from its peculiar crystalline structure—the hard external crust—the masses of magnetic pyrites which are scattered in large rounded nodules through it; but especially by its chemical constitution, as is seen in the following analysis, made under my direction by Mr. W. H. Brewer, of the analytical laboratory in Yale:

Eight grams were dissolved in HCl, NO_6H added, filtered from the insoluble part, the filtrate divided in six parts, four containing each 1 gram in solution, the other two containing each 2 grams. Iron and nickel were determined in each of the first four; the other two tested for Al, Mg, and Co. The nickel was separated from the iron by means of succinate of ammonia.

Iron	90.23	90.51	91.07	91.14
Nickel	9.68	9.05	9.68	9.05
Magnesium and sodium	....	....	trace	trace
Insoluble	.26	.26	.26	.26
	100.17	99.82	101.01	100.45

The amount of insoluble matter obtained from the 8 gms. was 0.21 gr., which, after long burning, weighed 0.16 gr. The loss was assumed as carbon. The residue, fused with carb. soda, gave traces of silica and iron, very distinct,

and nickel (?). The original meteorite also contained traces of sulphur. The amount of insoluble matter varied in different trials.

From these analyses it is evident that this is one of the most remarkable meteoric irons yet examined, in the large amount of nickel which it contains, being nearly 10 per cent. A very careful qualitative examination of the insoluble residue failed to detect appreciable quantities of those numerous various substances, i. e., cobalt, chromium, copper, manganese, which are often found in meteoric irons, as was first shown by Berzelius, and confirmed by many others. The peculiar form of carbon, however, which Berzelius first noticed, is found in small quantity in this specimen, and the remainder of the insoluble matter appears to have been a compound of silicon, nickel, and iron.

Shepard [2] gave the specific gravity as 6.835.

According to Reichenbach,[3] Salt River consists of a gray, amorphous, fine-grained groundmass which yields no figures upon etching (apparently plessite) with numerous intermingled fine needles and points of lighter color (Glanzeisen) unaffected by acids, to which he traces, here as in the case of the Cape iron, the high percentage of nickel. Cracks filled with graphite are mentioned and an ingrowth of iron glass.

Rose [4] distinguishes a gray, dull, groundmass and light elongated portions inclosed therein, which are arranged somewhat regularly according to the sides of an almost equilateral triangle and inclose longish, glistening shapes. According to the illumination after weak etching one-half of the section appears lighter than the other. Disregarding the regular position of the lighter portions, Salt River may according to him be compared with Senegal.

In 1884, Meunier[5] described Salt River as a mixture of tænite with iron carbide (campbelline), which yields very irregular figures by etching and established the fact of a carbon content. In 1893,[7] he explained that only braunine is present with schreibersite and rhabdite, and remarked a high percentage of phosphorus as characteristic. He did not furnish a new analysis, and neither his older nor newer characterization agreed with the results of Brewer's analysis.

In 1885, Brezina [6] placed Salt River in the same group of hexahedral irons which in the arrangement of inclusions of schreibersite shows a uniform orientation throughout the entire mass (Chesterville group). He remarked the surface of the meteorite covered with a rough bark in places.

Cohen [8] described the meteorite as follows:

Salt River is distinguished by a very rich content of schreibersite, and in this respect is surpassed only by Tocavita. This occurs sometimes in rounded grains 0.05 to 0.25 mm. in size, sometimes in elongated individuals, which, however, are not bounded by such straight lines as is usually the case with typical rhabdite. The latter are as a rule only 0.25 to 0.5 mm. long, but in exceptional cases attain a length of 4 mm. Where smaller individuals prevail, they are massed in large numbers, closely compacted and quite evenly distributed; in the neighborhood of large columnar crystals their number diminishes and the distribution is irregular. Such particles, poor in schreibersite, viewed at some distance, come out quite distinctly as dark, dull spots upon the prevailing mass rich in schreibersite and of a lighter, more lustrous appearance.

The schreibersite is almost without exception completely surrounded with gray kamacite and tænite lamellæ, the size of which stands in direct relation to the size of the grains. Then follow still other lamellæ of similar constitution without schreibersite inclusions; and since such lamellæ are frequent I do not consider their occurrence accidental. The lamellæ free from inclusions have a breadth of some 0.02 to 0.15 mm. and consist of an extremely fine-grained kamacite; the others, inclusive of the inclosed schreibersite, attain a breadth of 0.4 mm., and where these dimensions are approximated—which is only very seldom the case—a considerably coarser kamacite occurs, which shows a distinctly oriented luster in each individual grain. The light, brightly glistening tænite borders are narrow, but under the microscope are more sharply divided off from the kamacite. Between the lamellæ lies a grayish-black, dull plessite, in which appear under the glass tiny lustrous spangles. At about 200 diameters it shows a finely netted structure, and it seems that the plessite is entirely made up of tiny lamellæ of the same or very similar character with the larger ones already described. In the portions poor in schreibersite the plessite forms a coherent background, in which the lamellæ lie isolated; in the portions rich in schreibersite they occur in isolated constricted particles.

Analysis by Dr. J. Fahrenhorst:

Fe	Ni	Co	Cu	C	S	P	
90.89	8.70	0.85	0.04	0.02	trace	0.34	=100.84

Mineralogical composition (estimated):

Nickel iron	97.80
Schreibersite	2.19
Troilite	0.01
	100.00

Specific gravity (Leick), 7.6648 at 23.5° C. Nickel iron (estimated), 7.6786.

The relatively high content of copper and low specific gravity is also remarked by Cohen.

The meteorite is distributed. The Yale collection has 985 grams, the British Museum 524 grams, and the Harvard collection 304 grams.

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SAN ANGELO.

Tom Green County, Texas.
Latitude 31° 20′ N., longitude 100° 20′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found, 1897.
Weight, 88 kgs. (194 lbs.).

This meteorite was described by Preston [1] as follows:

The San Angelo siderite is oblong in shape and was, previous to cutting, 51 cm. long by 29 cm. wide and 14 cm. thick. Its weight was 194 pounds, or 88 kgs. A considerable portion of this siderite was obtained by Prof. H. A. Ward, chief of Ward's Natural Science establishment, through the courtesy of Prof. Geo. P. Garrison of the University of Texas, Austin, Texas, and he is indebted to Mr. James Abe March of San Angelo, Texas, for the facts in reference to its locality, and the manner in which it was found.

It was discovered by Mr. John Johnson on the prairie 7 miles south of San Angelo, Tom Green County, Texas, about July 1, 1897. The prairie on which the meteorite was found is called "Lipan Flats," a body of land entirely devoid of vegetation, without even mesquite trees. The meteorite was partially buried in the soil, and Mr. Johnson discovered it while riding horseback in search of cattle, and states that unless one rode over it, it would not have been seen, as the color of the soil and the meteorite were nearly the same.

The exterior surface of the mass is of a dark reddish-brown color, considerably spotted with large yellow patches. None of the original crust is perceptible. The surface is very much oxidized and some places can be seen where scales a quarter of an inch or more in thickness have flaked off, thus intimating that the mass had lain for many years in its original position where discovered. The surface of the iron is marked on all sides by large and characteristic pittings, some of them as much as 12 cm. in diameter.

At one end of the meteorite several ounces had been forced from the main mass, which has left a rough, jagged surface 5 by 6 inches.

This is of unusual interest, as the octahedral structure of the iron is beautifully shown by numerous octahedral faces, the largest of which is 1.25 inches in diameter and is very sharp and clear. So also are many of the smaller octahedral faces shown over this surface where the separation of the mass was made.

A portion of this part taken off has been forged in a blacksmith shop; this piece when polished and etched has the same general appearance as have all forged meteoric irons we have seen.

On slicing the mass we find the troilite nodules very scarce, the largest and only prominent one we have come across being 26 cm. in its greatest diameter and continuing of this size only through three thin slices. The Widmanstätten figures are brought out sharp and distinct on the etched surfaces, and are much more regular both in form and size, than in any other iron with which I am familiar. The rhombic figures are from 1 to 1.5 inches in diameter, and vary but little throughout the mass. The so-called Laphamite lines are prominently present, extending across the large patches. of plessite.

There are two exceedingly interesting veins which appear on either end of most of the slices, that are filled with a black, lustrous graphitic-looking mineral; the longest of these veins following the curve is 11 cm. and varies from 1 to 4 mm. in width; the other is 6 cm. long with a like variation of from 1 to 4 mm. in width.

Another distinguishing feature of this iron are the numerous small fissures or cracks, usually extending from the exterior surface inwards, and following in a zigzag course along the edges of the kamacite plates, and in some instances the rhombic form of the Widmanstätten figures as seen on the etched surface, is strongly outlined by these fissures. These show clearly that with a little more heat the expansion of these cracks or fissures would have caused masses to separate from the iron, which would tend to cause the large pittings, as suggested by me in an article in the January number of this year of this journal. In one case, if a separation had taken place along these fissures, it would have created a

cavity or pitting 4 inches in diameter and 1 inch or more in depth, while numerous smaller pittings could have been created in the same way as suggested by following the outline of the fissures on cut.

The following is an analysis of the San Angelo meteorite by Mariner and Hoskins of Chicago, Illinois:

Fe	Ni	Co	Cu	P	S	Mn	Si	C	
91.958	7.86	trace	0.04	0.099	0.032	trace?	0.011	trace	=100

Specific gravity, 77.

The meteorite is distributed. Ward possesses 4,516 grams.

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Sancha Estate. See Fort Duncan.

Sanchez Estate. See Fort Duncan.

SAN EMIGDIO.

San Emigdio Mountains, San Bernardino County, California.
Approximately latitude 35° N., longitude 116° W.
Stone. Spherical chondrite (Cc) of Brezina; Belajite (type 44) of Meunier.
Found prior to 1887; described 1888.
Weight, 36 kgs. (80 lbs.).

This meteorite was chiefly described by Merrill.[1] A brief account was given in the American Journal of Science and full details later in the Proceedings of the United States National Museum, as follows:

The fragments came into my possession through the kindness of Mr. Thomas Price, of San Francisco. The stone is stated by Mr. Price to have been found by a prospector in the San Emigdio Mountains, San Bernardino County, in the southern part of California, and to have been sent him for assaying, it being mistaken for an ore of one of the precious metals.

Unfortunately, before its true nature was discovered, the entire sample was put through a crusher, so that no specimens of more than a few grains weight were obtainable. Nothing whatever can be learned in regard to the fall of the stone, and its meteoric origin is assumed from its structure, composition, and the presence of the well-known black coating on the exterior surfaces of many of the larger particles. The weight of the entire mass was stated by the finder to be about 80 pounds.

All the fragments are stained throughout a dull reddish-brown color, through the oxidation of the metallic portions. The stone breaks with an irregular fracture, and presents on casual inspection nothing indicative of its meteoric origin; a polished surface, however, shows abundant silvery-white flecks of metallic iron in sizes rarely over 1 mm. in diameter, and numerous larger spherical bodies of a green color suggestive of olivine, never over 2 or 3 mm. in diameter, however.

In thin sections the true nature of this iron is at once apparent. Under a power of 50 diameters a large number of rounded and irregular chondri and crystal fragments with scattering blebs of metallic iron and pyrrhotite, embedded in a groundmass the true nature of which is so badly obscured by ferruginous stains as to be almost irresolvable, but which, from a study of the thinnest slides obtainable, appear to be fragmental, are to be found.

The readily determinable constituents, named in the order of their abundance, are olivine, enstatite (bronzite), metallic iron, and pyrrhotite; there are also occasionally very minute fragments of an almost completely colorless mineral, which between crossed nicols shows evidence of polysynthetic twinning. These are too small and irregular for accurate determination, but from certain indefinite and obscure characters I have felt inclined to regard them as belonging to a mineral of the pyroxene group rather than as a plagioclase feldspar. Their appearance resembles very closely that of the twinned magnesian pyroxenes obtained by Fongue and Lèvy in artificial meteorites.

Olivines occur in the form of both monosomatic and polysomatic chondri and as scattered fragments in the groundmass. The chondri show a variety of structural features. In certain cases they are made up wholly of crystalline granules of olivine with scarcely a trace of amorphous matter, or, again, show well developed porphyritic crystals embedded in a very finely granular or even glassy base, or a very finely granular almost dustlike and very obscure structure throughout. The porphyritic olivines are perfectly clear and colorless, with but few cavities or inclusions, though sometimes including portions of its amorphous base. Forms are abundant resembling the polysomatic chondri figured by Tschermak from sections of the Mezo-Madaras, the Homestead, and the Sena meteorites. They are not in all cases circular in outline, as seen in the section, but are often irregular and fragmental in appearance. Monosomatic forms, as a rule, show a more nearly spherical outline than do the polysomatic forms. Occasional monosomatic

gratelike forms are met with in which the crossbars are curved, and sometimes extend entirely across the face of the chondrus, or again show short and interrupted forms. The olivines of the groundmass are always fragmental.

The enstatite, like the olivine, occurs both in the form of chondri and as scattered fragments in the groundmass. It is distinguishable from the olivine by its gray color, less transparency, well-developed cleavages parallel to the vertical axis, and by its insolubility in acids. The position of the plane of the optic axes could not be made out with certainty with the instrument at command, but as the mineral is biaxial, nonpleochroic, and extinguishes always parallel with the vertical axis, there is apparently no doubt as to its true nature. The chondri are sometimes composed wholly of enstatites, with small quantities of interstitial amorphous base, of olivine and enstatite together. The distinction between the two minerals is, owing to their small size and imperfect development, often impossible by the microscope alone. A more common form of the enstatite is that of irregular fragments with a radiating or fan-shaped structure. Other quite perfectly spherical, very minute forms occur, consisting of an almost wholly amorphous material or with only faint beginnings of crystallizations shown by rays of light radiating across the surface as the stage is revolved. The exact mineralogical nature of these can not be determined.

The metallic iron occurs in lumps and in very irregular areas, or as injected drops in the interior of the chondri. It is of a silvery-white color by reflected light, and readily distinguished from the pyrrhotite with which it is nearly always associated, and which shows a bronze-yellow luster. In a few instances grains or chondri of olivine or enstatite are entirely surrounded by a dark border of iron and pyrrhotite, as Tschermak has figured from sections of the Cabarras meteorite. In such cases the iron often penetrates slightly into the mass of the mineral, having evidently exercised a corrosive action.

The structural features of the groundmass are, as already observed, very obscure. It consists of minute angular particles of olivine and enstatite embedded in a matrix so fine and so badly stained by iron oxides that its true nature can not be satisfactorily ascertained. From the fact that this coloring matter has become so thoroughly disseminated throughout the whole mass, I am inclined to regard it as tuffaceous. A wholly granular, glassy, or partially devitrified base would seemingly have proven less pervious and shown the ferruginous staining only along lines of fracture and cleavage.

The chemical investigation of the stone was rendered somewhat unsatisfactory owing to the badly oxidized condition of the metallic portions. For the results given below I am indebted to Mr. J. E. Whitfield, of the U. S. Geological Survey. The complete analysis gave: Metallic portion, 6.21 per cent; soluble in hydrochloric acid, 52.19 per cent; insoluble in hydrochloric acid, 41.60 per cent. Specific gravity, 3.57. The metallic portion yielded:

Fe	Ni	Co	
88.25	11.27	0.48	=100.00

The soluble portion is presumably all olivine, together with pyrrhotite and secondary iron oxides. An analysis of this portion was rendered of no value from the fact that the first attempt at a complete separation of the two silicate minerals by digestion in dilute hydrochloric acid was a failure, and the badly weathered condition of the stone rendered a second attempt scarcely worth the while. The insoluble portion was separated by prolonged digestion in dilute hydrochloric acid, followed by boiling sodic carbonate. The remaining powder showed under the microscope very pure enstatite fragments, together with rarely a minute grayish particle that acted but faintly on polarized light and the exact mineralogical nature of which could not be ascertained. Mr. Whitfield's results on this powder were as follows:

SiO_2	54.42		0.91
FeO	14.03	0.19	
CaO	2.46	0.04	0.95
MgO	29.11	0.72	
	100.02		

This, it will be observed, is a highly ferriferous enstatite (bronzite) with perhaps a small admixture of a lime-bearing pyroxenic mineral as indicated by the microscope. The relative proportions of the various constituents as they existed in the fresh rock, can not be estimated with any degree of certainty from the figures as above given for the reasons already stated. * * *

Meunier [2] remarked concerning the meteorite as follows:

This is a very exceptional stone at first sight and one upon which we possess only a brief note by Merrill.

The stone is granular, of a reddish-brown color and only shows its metallic elements upon the polished surface. In thin sections under the microscope its meteoric nature becomes apparent; chondrules of enstatite of more than 1 mm. in diameter detach themselves in the midst of limpid crystals of which the most abundant are peridotic, and opaque grains where can be readily seen nickel iron and pyrrhotine or magnetic sulphide of iron.

Specific gravity at 11°, 3.59. The magnet extracts from it 7.02 per cent of the magnetic substance. The residue, 92.98 per cent, separates under the action of the acid into 52.13 per cent of attackable minerals and 40.75 per cent of pyroxenic compounds. These figures differ but little from those of Whitfield.

On comparing the meteorite of San Emigdio with the rare masses preserved in the museum it appears that the cosmic rock called belajite most nearly approaches it. It is a very interesting type and one which demands fresh study.

Brezina[3] classed the meteorite as a spherical chondrite, remarking that in spite of its strongly rusted character it showed the spherical chondri plainly.

As stated by Merrill,[1] but a small quantity of the meteorite is preserved. Wülfing[4] lists 180 grams, of which the U. S. National Museum possesses 119 grams.

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3. 1895: Brezina. Wiener Sammlung, p. 256.
4. 1897: Wülfing. Die Meteoriten in Sammlungen, p. 305.

San Francisco del Mezquital. See Mezquital.

San Gregorio. See Morito.

SAN PEDRO SPRINGS.

Bexar County, Texas.
Latitude 29° 28′ N., longitude 98° 29′ W.
Stone. White chondrite (Cw) of Brezina.
Found, 1887.
Weight, 72 grams.

The first mention of this meteorite seems to have been by Bement,[1] who entered it in his catalogue of June, 1894, with a weight of 72 grams. Brezina[2] recorded it in 1895 as a stone simply. Ward's[5] catalogue gives the classification as a white chondrite.

No further data regarding the meteorite seem to have been published.

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4. 1903: Berwerth. Verzeichniss, p. 77.
5. 1904: Ward. Catalogue of the Ward-Coonley Collection, pp. 62 and 87.

SANTA APOLONIA.

State of Tlaxcala, Mexico.
Latitude 19° 14′ N., longitude 98° 15′ W.
Iron. Octahedrite (O) of Brezina.
Found, 1872.
Weight, 1,050 kgs. (2,317 lbs.).

The only published mention of this meteorite of which the present writer is aware is the mention by Ward[1] who gives the above data. He also states that the original mass (1,050 kgs.) is in the Museum of the Instituto Geologico, City of Mexico.

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Santa Catarina Mountains. See Tucson.

Santa Fe County. See Glorieta Mountain.

Santa Rita. See Tucson.

Santa Rosa, 1837. See Coahuila.

Sackatchewan. See Iron Creek.

SCOTT.

Scott County, Kansas.
Stone.
Found 1905; described 1906.
Weight, 135 grams.

This meteorite was described by Merrill [1] as follows:

Together with the samples of Modoc meteorite forwarded, Mr. Freed included two small pebblelike masses which had been found by his boy and which it was thought might possibly be also of meteoric origin. One of these was of ferruginous quartzite. The other, some 40 by 60 mm. in greatest diameter, and weighing 135 grams, proved to be meteoric. This, although weathered to a dull rusty brown on the surface, still showed distinctly the usual pittings, and on a polished surface presented a dull dark-gray ground thickly spotted with small points of metallic iron and occasional rounded areas recognized with the unaided eye as chondrules. Under the microscope this is found to consist of an extremely fine tufaceous ground carrying large clear olivines in single crystals and scattered aggregates and numerous chondri of olivine and enstatite. The olivine chondri are in part polysomatic and in part of the common barred or gratelike character. The enstatite chondri are most commonly in radiate forms. The entire structure and even the identity of some of the mineral constituents are much obscured by iron oxides which have stained the mass an ocherous red throughout. The metallic constituents are much more abundant than in the Modoc stone named above.

Although differing somewhat from Washington's description and my own studies on the meteorite of Jerome in the adjoining county of Gove, the differences are so slight as to be seemingly nonessential, and I am inclined to regard this as a straggler from the Jerome fall which, it will be remembered, was found on April 10, 1894, on the Smoky Hill River and has been described in detail by Doctor Washington. There is, however, a chance for a difference of opinion on this subject.

Although Merrill is inclined to class this meteorite with Jerome, in the view of the present writer it should be regarded as an independent fall, since the place of find of the Jerome meteorite was 40 miles away.

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SCOTTSVILLE.

Allen County, Kentucky.
Latitude 36° 43′ N., longitude 86° 6′ W.
Iron. Hexahedrite (H) of Brezina; Braunite (type 3) of Meunier.
Found 1867; described 1887.
Weight, 10 kgs. (22 lbs.).

The first account given of this meteorite was by Whitfield,[1] as follows:

This meteorite was found about the middle of June, 1867, by Mr. Jas. H. More, while hoeing tobacco, near Scottsville, Allen County, Kentucky. In shape it resembles a wedge, the thickness at base being 14 cm., width 18 cm., and length 16 cm., the mass as found weighing a little more than 10 kgs., and having the characteristic pitted surface. A section shows nodules of troilite, varying in diameter from barely visible points to about 12 mm. The markings on an etched surface are exceedingly fine and require the aid of a lens to distinguish them. There appear to be two sets of figures, one of long, very fine lines representing octahedral cleavage, the other series being smaller, more crowded, and barely perceptible.

An analysis gave the following composition:

Fe	Ni	Co	S	P	C	
94.32	5.01	trace	0.34	0.16	0.12	=99.95

Specific gravity, 9.848.

This iron, as regards markings and general appearance of section, resembles the Scriba and Salt River meteorites more nearly than any others represented in the U. S. National Museum collection; but as no complete analyses of these two irons are at hand the chemical comparison can not well be made. The percentage of iron appears rather high, but duplicate determinations gave corresponding figures. The material for analysis was received by Professor Clarke from Messrs. Ward and Howell, of Rochester, New York, to whom we are indebted for the privilege of description.

Cohen [2] published an analysis by Fischer which was as follows:

Fe	Ni	Co	Cu	P	Residue	
93.14	5.73	0.99	0.10	0.15	0.02	=100.13

Huntington [3] saw in the meteorite a resemblance to the Coahuila irons, and suggested that it might be a part of the same fall. His account is as follows:

The whole character of this iron, including the etched surface, closely resembles that of the Coahuila irons. On breaking small slabs of the Scottsville block it showed the same cleavage as the Saltillo iron. The fine parallel cracks appear under the first blows of the hammer, and then the slab breaks, regardless of the way it is held, in two directions only at angles of about 132° and 53°, presenting a single cleavage plane with the marked flaky appearance characteristic of the Saltillo iron. That these masses were found in places so remote does not seem to preclude their having belonged to one individual, as appears from the case of the Rochester (Indiana) meteorite. It therefore is possible that at some remote period an enormous iron meteorite may have passed over the entire breadth of the United States, the main mass reaching Mexico, but large fragments breaking off and falling during its passage across the country.

Meunier [4] grouped the meteorite as Braunite, and described it as follows:

It is rich in phosphorus and has a few grains of easily recognizable pyrrhotine. Carbonaceous matter is abundant.

Brezina [5] made it a normal hexahedrite, and described it as follows:

The Scottsville iron shows large pittings and a peculiar wrinkling upon the natural exterior; in the section it shows frequently a larger expanse of brass-yellow troilite besides smaller areas of tombac-brown troilite. Occasionally the inclusions are made up of two bodies in both kinds of troilite. Fissures of 5 to 6 cm. in length, springing from the exterior surface and running parallel to one another, sometimes end in pockets of troilite. The Neumann lines are numerous, fine, and regular in direction.

Cohen [6] found that it took on more or less permanent magnetism. Later [7] he described it as follows:

The quite uniformly distributed etching lines are of exceptional delicacy, and lie very close together; here also occur, as seen under a strong glass, a few systems which are more prominent than the others by reason of their length if not also on account of their much greater distinction. The etching pits are numerous and of unusual size; the luster is uniformly oriented over the entire etched surface, but not always in the same way. Where the pittings are isolated it appears strong and somewhat satiny; in many places, however, there occur also dark particles of a dull luster which may be due to the fact that the pittings are larger here and run together, and the shallow depressions diffuse the reflected light and so appear darker. The etching lines run unchanged through both portions. The small rhabdites, which according to the content of phosphorus must be present in considerable numbers, escape direct observation. The larger needles up to 1.5 mm. in length are massed together in a few places; here the etching surface has a slightly roughened appearance, probably due to the fact that the needles are enveloped with a covering of nickel iron less assailable by acid. The crust appears to be an oxidized fusion crust, in proximity to which some iron glass occurs.

Scottsville takes on strong permanent magnetism and has quite strong coercive force; after intense heating and slow cooling it behaves like malleable iron, while quick cooling after heating to redness has no effect. Leick determined the specific magnetism at 0.19 units per gram.

Analysis by Knauer:

Fe	Ni	Co	Cu	Cr	P	S	C	Residue	
94.03	5.33	0.95	0.04	0.02	0.23	0.07	0.00	0.01	=100.68

Specific gravity, 7.7959.

The meteorite is distributed. Vienna possesses 1,570 grams, Ward 1,153 grams.

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SEARSMONT.

Waldo County, Maine.
Latitude 44° 20′ N., longitude 69° 10′ W.
Stone. Spherical chondrite (Cc), of Brezina; Montrejite (type 38) of Meunier.
Fell May 21, 1871, 8.15 a. m.; described, 1871.
Weight, 5.4 kgs. (12 lbs.).

The first description of this meteorite was by Shepard,[1] as follows:

For the particulars concerning the fall of the Searsmont meteorite, I am indebted to Mr. E. B. Sheldon, postmaster of the adjoining village of Searsport, and to the Republican Journal of Belfast, Maine, of Thursday, May 25. Mr. Edward Burgess, of Searsmont, furnished the short notice contained in the newspaper. He states that the fall took place in the southern part of the town about 8 o'clock on Sunday morning, the 21st inst. "There was first heard an explosion like the report of a heavy gun, followed by a rushing sound resembling the escape of steam from a boiler. The sound seemed to come from the south and to move northwardly. The stone fell in the field of Mr. Bean, the flying earth being seen by Mrs. Buck, who lived near. The hole that it made was soon found and the stone dug out. It was quite hot and so much broken as to be removed only in pieces. The outside showed plainly the effect of melting heat. It struck with such force as to penetrate the hard soil to a depth of 2 feet."

The following is the substance of Mr. Sheldon's letter:

Mr. Luce, who dug the stone tells me he reached the spot about 15 minutes after it struck, when he found the fragments still quite warm. The largest piece weighed 2 pounds. Altogether the pieces amounted to 12 pounds. They emitted the odor given off by stones violently rubbed together. The hole produced by its descent was vertical in its direction and 2 feet in depth. The character of the soil was a hard, coarse gravel; and the shattering of the stone was produced by its finally meeting 3 large pebbles, each about 4 pounds in weight, in the course of its descent. "Mrs. Buck, who saw it fall, or rather saw the scattering of the soil on its entering the ground, was reading at the time in the house, distant about 30 rods from the spot. The time was 15 minutes past 8. She first noticed a report about as loud as that of a gun, or of a rock blast, such as they hear from a lime quarry about a quarter of a mile distant. This was followed by a rumbling noise, as of a number of carriages passing over a bridge. She rose and looked out from a back door, then recrossed the room to the front door, where, after the lapse of about 10 seconds, she saw the dirt fly from the contact of the stone with the earth. She thought it must have been nearly 2 minutes from the first report until the stone struck the ground. No one went to the place for 20 or 25 minutes. The report was heard in Warren, 12 miles to the southwest; likewise a hissing sound of as escaping steam. No report or sound was heard in Searsmont village, 3 miles to the northeast."

Through the kind assistance of Mr. Sheldon, I am in possession of the largest remaining mass of this meteorite. Its weight is 2 pounds. Fully one-half of its surface is coated with the original crust. Its shape would seem to denote an oval, subconical figure in the original mass, with a flattish base so as on the whole to have approached the shape of the famous Duralla (India) stone, now preserved in the British Museum. The coated part of my specimen, which corresponds to a portion of what constituted the base of the supposed cone, differs in shape and color from the two oval undulating sides, which make therewith angles of between 60° and 70°. The broadest of these sides (above 3 inches in length) where it meets the base, forms a blunt rounded edge, is obscurely striated vertically to the intersection, and shows a slight thickening about the edge, as if matter had been swept over from above and accumulated somewhat on the under side. Nothing is plainer than the distinction between the upper sides and the base. The crust of the latter is perfectly black, more thoroughly fused, with a blebby, somewhat glassy, reticulated surface, whose lines are without any order; while the upper surfaces are more even and almost destitute of the blebby and veined appearance. Feeble striæ are visible near the basal side, all of which are perpendicular to the same. The color of the upper surface is brownish black; and these are wholly without luster.

The thickness of the crust is more than double that found in any stone belonging to my collection—amounting at least to one-sixteenth of an inch. The stone is rather below the average in respect to frangibility. The color is bluish white, and remarkably uniform except from feeble stains of peroxide of iron, and from silvery-white, metallic points, produced by the meteoric iron. More than half the stone is in the form of rounded grains, mostly with roughened or drusy surfaces, and of a size rarely exceeding mustard seeds. Between these and often partially coating them, is a fine-grained, subcrystalline, white or grayish-white mineral, which I take to be chladnite. It is rather loosely coherent, and without visible crystalline structure. Indeed, as seen with the microscope, it is often porous, reminding one of the silicious skeletons obtained in fluxing certain silicates in blowpipe experiments. This white mineral may form a quarter or more of the stone.

The rounded globules are bluish-gray, rarely with a faint tinge of yellow, vitreous luster and translucent, with two imperfect oblique cleavages. On the whole, they resemble the unaltered grains of boltonite more than any of our terrestrial minerals; and differ only in their greater tendency to assume the globular figure.

Minute points of bright meteoric iron are very thickly scattered through the mass. A few grains of troilite, the largest of the size of large kernels of Indian corn (maize), likewise present themselves, together with a single blackish mass of similar dimensions, which on being touched with the point of a knife was found to be soft and left a bright metallic streak. It is probably a plumbaginous aggregate. Specific gravity of the aggregate, 3.626.

In general character it approaches most nearly to the stones of Quenggouk (Pegu, India) that fell December 27, 1857, differing from them in having more of the fine whitish gangue, and in possessing a thicker and more blebby crust. It also presents points of resemblance to the Aussun (France) meteorite of December 9, 1858; but the latter has a much thinner crust, a darker colored general basis or gangue, much larger globules, and is at the same time a firmer stone.

There is even an internal similarity between the Searsmont meteorite and that of Duralla. They approach each other in thickness and general character of the crust; but the whole of the latter is darker, and the regularity in the shape of its globules is less marked.

Should I succeed in recovering a portion of the now widely scattered fragments of this interesting stone, I shall enter upon a more detailed examination of its character.

Smith [2] gave the following analysis of the meteorite:

Immediately after the fall of this meteoric stone a portion of it was placed in my hands for examination. The circumstances accompanying its fall as well as its physical characters have been described by Professor Shepard.

It resembles very closely the Mauerkirchen stone that fell in 1768, the crust of the specimens corresponding quite closely to that in thickness and appearance; the Mauerkirchen stone, however, has not well-marked globules like that of Searsmont; in this respect it corresponds more nearly with the Aussun, as already stated by Professor Shepard.

The specific gravity of the specimen examined was 3.701. The nickeliferous iron and stony matter were separated mechanically for analysis. One hundred parts of the meteorite gave—

Stony matter (including a little sulphuret of iron)	85.38
Nickeliferous iron	14.62
	100.00

The iron afforded:

Iron	90.02
Nickel	9.05
Cobalt	0.43
	99.50

Phosphorus and copper were not estimated. The stony part, treated with a mixture of hydrochloric and nitric acids, gave:

Soluble in the acid	52.30
Insoluble in the acid	47.70
	100.00

The soluble portion afforded:

Silica	40.61
Protoxide of iron	19.21
Magnesia	36.34
Sulphuret of iron	3.06
	99.22

Leaving out the sulphuret, which is obviously only a mechanical mixture, this soluble part is evidently an olivine, which is almost invariably the case with soluble portions of meteoric stones. The insoluble part was composed as follows:

Silica	56.25
Protoxide of iron	13.02
Alumina	2.01
Magnesia	24.14
Alkalies, Na_2O, K_2O, with trace of Li_2O	2.10
Chrome iron, small black specks not estimated.	
	97.52

The above analyses give for the composition of the stone:

Nickeliferous iron	14.63
Magnetic pyrites	3.06
Olivine	43.04
Bronzite or hornblende, with a little albite or orthoclase, and chrome iron.	39.27
	90.00

With the bronzite there may also be enstatite, which would be confounded with the former if existing in the stone.

Meunier [3] classed the meteorite as Montrejite, and Brezina [4] as a spherical chondrite.

Only the 2 pounds obtained by Shepard seems to be known. Of this Amherst has nearly all, Wülfing [5] mentioning in addition 345 grams.

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Searsport. See Searsmont.

SELMA.

Dallas County, Alabama.
Latitude 32° 25′ N., longitude 87° 1′ W.
Stone. Spherical chondrite (Cc) of Brezina.
Found, 1906.
Weight, 140.6 kgs. (310 lbs).

The first mention of this meteorite was by Merrill,[1] as follows:

The writer has received notice from a correspondent in Alabama of the finding, near Selma, in that State, of a heretofore undescribed meteorite. The mass is reported as weighing upwards of 300 pounds, and is of Brezina's kugel chondrite type, much resembling the well-known stone from Tieschitz, in Moravia. It will be known as the Selma, Alabama, stone. A detailed description will be published later.

A later description was given as follows:[2]

The information relating to the finding of the stone described below was sent the writer by Mr. John W. Coleman, to whom he is indebted for a small fragment and the privilege of describing, as well as information concerning its weight and general appearance.

The stone, as found, appears to have been a nearly complete individual, a piece of some 3 or 4 pounds weight only having been broken from one side. In shape it is roughly polygonal, without strongly marked flutings or pittings, and is considerably shattered and cracked, either from exposure or from the shock of striking the earth.

The specimen received is without crust, and weathered to a dark reddish-brown on the surface. Total weight of the stone, as reported, 310 pounds (140.6 kgs.). Greatest dimensions, as given by Mr. Coleman, 24 by 14 inches (60.96 by 35.5 cm.); circumference, 69 by 44 inches (175 by 118 cm.). Locality, 2 miles north and a little west of Selma, near the Summerfield Road.

Although not found at the time, the date of fall is considered by Mr. Coleman as July 20, 1898, at about 9 o'clock in the evening. This is on the authority of various witnesses of "a great light passing from east to west, leaving behind it a trail of fire 10 or 12 feet long, and accompanied by a rumbling noise." One of the persons was so sure of the place of fall that a search was instituted for it at the time. There is, of course, no possibility of establishing absolutely the identity of the stone so recently found and the one seen to fall, but the close proximity of the localities makes it possible.

Additional data subsequently given by Mr. C. G. Gilbert, who visited the locality in the interests of the late H. A. Ward, are as follows:

The position of the stone, as found, was such as to suggest that it was first unearthed in the work of digging a trench for the purpose of laying a drain pipe and rolled one side, as would have been done with an ordinary bowlder, where it lay among the weeds until its true nature was surmised by Mr. Coleman.

As described by Mr. Gilbert in a letter to the writer, the stone at first sight is "a completely formless polyhedral block, but on longer inspection it resolves itself into something of a characteristic aerolite form—a blunt quadrangular pyramid with smooth, unpitted faces and rounded edges." The thickness of the block he gives as 35.56 cm., the basal edges measuring, respectively, 35.56, 43.18, and 50.8 cm. The blunt apex of the pyramid—evidently the front side during flight—was covered for a distance of about 15.24 cm. with a thin coating of carbonate of lime, which presumably marked the depth to which the stone penetrated on first striking the ground. This portion of the stone is smooth, except for the lime coating, and shows, as do the sides, the original though now oxidized crust. The base is, however, rough, with a somewhat scaly brown-black appearance, quite unlike the rest of the surface, and is divided by numerous fissures, due to weathering. "The whole appearance," writes Mr. Gilbert, "indicates that it represents what was once a fine, large, well-orientated aerolite, many of the characteristics of which have become obliterated through exposure."

Macroscopically, the stone is dense, of a dark-gray color, and sufficiently compact to receive a good polish. Cut surfaces show abundant "kugel" chondri of all sizes up to 3 mm. in diameter, though forms above 1.5 to 2 mm. are rare. These are so firmly embedded as for the most part to break with the stone. The metallic portion is quite inconspicuous to the unaided eye.

Under the microscope in thin sections, the stone is seen to be composed of extremely variable chondri, often fragmental, and scattered particles of silicate minerals embedded in a dark opaque ground which, by reflected light, shows up as a network of deep-blue metallic iron and its oxidation products and brilliant points of yellow-white troilite. Olivine, enstatite, and a monoclinic pyroxene constitute the silicate portion. These are, in large part, in the form of fragmental chondri, though sometimes quite perfectly oval. The olivine chondri show the common barred and porphyritic forms, the latter with a more or less glassy or fibrous base. Some of them are mere aggregates of polarizing points without evident interstitial matter. There are also occasional large, scattered, single crystals and fragments not constituting chondri. The enstatites occur under similar conditions and also in fan-shaped radiating forms, very much broken and otherwise imperfect, and in dense crypto-crystalline forms, presenting no opportunity for optical determination. The monoclinic pyroxenes are the least abundant of the silicates and show the usual (in meteorites) polysynthetic twinning and low (15° to 20°) angles of extinction. They are colorless or of a gray color and, but for the inclined extinctions, distinguished with difficulty from the enstatite. They occur in chondri as well as in scattered isolated forms. No feldspars nor minerals other than those noted were observed.

The most striking feature of the stone is the broken and fragmental condition of the chondri and the variety of forms manifested. It is best comparable, so far as the writer's experience goes, with that of Tieschitz, Moravia, described by Tschermak. It belongs, therefore, to Brezina's class of kugel chondrites Cc. It will be known as the Selma, Alabama, meteorite, and is the fourth stony meteorite thus far reported from that State.

Since the above was written, the stone has been purchased by the American Museum of Natural History, New York City.

Hovey [3] gave the following description of the meteorite:

The collection of meteorites in the foyer of the museum has recently been enriched by the addition of an aerolite, or stone meteorite, which was found in March, 1906, about 2 miles north-northwest of Selma, Alabama, near the road to Summerfield. The fortunate finder was Mr. J. W. Coleman, of that city.

Mr. Coleman states his belief that the meteorite fell on July 20, 1898. At about 9 o'clock of the evening of that day at least five observers at different stations from half a mile to two and one-half miles from where the stone was found saw a brilliant meteor pass through the air leaving a "trail of fire 10 or 12 feet long." The meteor seems to have traveled in a direction somewhat west of north, and its flight is said to have been accompanied by a heavy rumbling noise. No other similar meteorite has been noted in the immediate region, and this meteorite does not seem to show any more decomposition of surface than might have taken place in the 8 years that have elapsed since the date of its assumed fall. The identity of this find with the shooting star of July 20, 1898, can not of course be established with certainty, but it seems probable.

This meteorite, photographs of which are reproduced, is one of the 10 largest aerolites ever found. Most such bodies break to pieces in the earth's atmosphere, probably on account of unequal heating due to friction against the air, and shatter into scores and even hundreds or thousands of fragments before they reach the ground, and this is the largest entire aerolite now in the United States.

The Selma, as this meteorite will be called, is 20.5 inches high, 20 inches wide, and 14 inches thick, and it weighs 306 pounds (138.6 kgs.). A piece of perhaps 4 pounds weight has been lost from the mass, hence it is probable that the original weight was 310 pounds. It has lain buried in the ground where it fell for several years, so that the original glassy crust has been largely decomposed and washed away, and the characteristic "thumb-mark" pittings have been partly obscured. Some portions, however, remain as in indication of its original condition. In shape the meteorite is roughly polygonal, without pronounced orientation features, though it seems probable that the side shown in one of the figures was the "brustseite," or front, during flight through the atmosphere. The mass is deeply penetrated by cracks on both sides, but principally on the rear. The cracks do not radiate from one or more centers, nor is the apparent rigidity of the mass affected by them; hence they do not seem to have been caused by shattering due to impact with the earth. The position and character of the fissures indicate that they were due to unequal heating through friction with the air during flight through the atmosphere, the tension produced being insufficient to cause complete fracture.

Macroscopic examination of a cut and polished fragment shows the stone to have a dark brownish-gray color, and to be made up of spherical or nearly spherical chondri, or particles, firmly embedded in a similar matrix. The largest chondri are one-eighth inch (3 mm.) in diameter, though those more than one-half as large are rare. A strong magnifying glass is needed to show one the minute grains of iron scattered through the mass.

The specific gravity of the stone is 3.42, as determined upon a fragment weighing 4.56 ounces (129.4 grams) and showing some effects of decomposition. A chemical analysis of the material has not yet been made, but Dr. G. P. Merrill, of the United States National Museum, has had sections cut and polished, and has published a brief scientific description of the meteorite in the Proceedings of the United States National Museum for 1906, where he gives the find the name which we have adopted.

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SENECA FALLS.

Seneca County, New York.
Here also Seneca River.
Latitude 42° 55′ N., longitude 77° 0′ W.
Iron. Medium octahedrite (Om) of Brezina; Caillite (type 18) of Meunier.
Found 1850; described 1852.
Weight, 4 kgs. (9 lbs.).

The first description of this iron was given by Root,[1] as follows:

A mass of malleable iron weighing 9 pounds was found last fall in digging a ditch on a farm near the free bridge on the Cayuga side of the Seneca River. It was drop-shaped, about 4 inches in diameter and 7 inches in length. When found it was coated with oxide of iron.

The surface was uneven and some of the prominent parts were terminated by planes of octahedral crystals. Through the kindness of Jacob Crowningshield and Leroy Partridge, of Seneca Falls, I am in possession of a piece of the iron weighing 3 pounds, being the middle section of the original specimen. The internal structure of the mass was very obvious from the lines of crystallization presented on the faces cut by the saw in dividing. After the faces were smoothed and etched the figures were very distinct and beautiful, resembling those on the Texas meteorite in the Yale cabinet. When filings of the faces cut were dissolved in nitric acid and the iron precipitated by ammonia the solution, on adding potash, gave very manifestly the reaction of nickel, and hence the specimen is undoubtedly *meteoric iron*.

It may be an interesting fact that the locality where this iron was found is only a few miles from Waterloo, in Seneca County, where a meteorite fell in 1827, as has been stated by Professor Shepard.

A complete description and analysis was given by Shepard,[2] as follows:

This iron was very briefly announced by Prof. O. Root, of Hamilton College, Clinton, New York. The weight of the mass was between 8 and 10 pounds. It was picked up by a farmer while engaged in excavating a ditch, his attention having been arrested by its unusual weight as compared with ordinary stones. A thick coating of limonite (hydrous oxide of iron) formed the entire outside of the mass. Its general figure was somewhat drop shape, although the customary depressions found on the surfaces of meteorites were visible also in the present instance.

I am indebted to Professor Root for a very perfect tetrahedral fragment (of about 2 ounces weight) which must have formed the little end of the meteor; and to LeRoy C. Partridge, of Seneca Falls, for a thick slice (of 4.5 ounces) which, apparently, is a section across the mass next below the above.

The broad unshaded bars, which meet at angles of 60° and 120°, are quickly brought out by the acid, their own surfaces not being corroded in the slightest degree by the chemical action, which is confined to the linear intervals between the bars, to the triangular and rhomboidal patches, and to the borders of the very circumscribed and irregular areas, situated upon a few of the bars themselves. These regions are completely covered during the operation with little bubbles of nearly pure hydrogen gas.

After the corrosion has been permitted to go on for a number of minutes the linear intervals above mentioned exhibit a checked appearance as if a single row of little prisms had been inserted between the broad bars. These prisms evidently consist of the same alloy as the broad pillars between which they are thrust since their tops, like the surfaces of the bars, escape corrosion and are left after the action has ceased at the same level with the bars themselves. Their presence, in the peculiar position they occupy, confers upon this iron a very remarkable feature, totally unlike any other I have seen. Indeed in all other highly crystalline specimens we have a series of perfectly continuous lines and edges in place of the checkered rows here displayed.

The shaded triangular and rhomboidal areas, when their surfaces are well cleaned by a dilute aqua regia (and polished) and examined under a lens, are seen to be finely striated with the same beaded or checkered lines as those above described in the linear intervals.

The more circumscribed areas consist of a silver-white mineral believed to be new and which will be more particularly described further on. This substance is not acted upon by the hydrochloric acid, but an envelope of meteoric pyrites, by which it is more or less surrounded, is briskly attacked, and from these regions the odor of sulphuretted hydrogen is plainly perceived.

The want of continuity in the larger bars and their rounded terminations also serve still further to distinguish, at first glance, the Seneca River iron from nearly all others.

A solution of sulphate of copper dropped upon a moistened surface of the iron immediately gives rise to a precipitate of metallic copper. It is therefore not in the passive state of the Greene County (Tennessee) iron and of some others, as discovered by Wohler.

Beneath the coating of limonite is found a very distinct layer of compact black magnetite which must have constituted the original crust of the meteor. Its thickness in some places is 0.1 inch. The specific gravity of the iron if 7.337.

It possess a medium hardness and takes a very high polish, having the customary grayish-white tint. In this respect, as well as in many other particulars, it differs widely from the Burlington iron, which is remarkable for its whiteness. The tendency to cleavage in the Seneca River mass is very obvious, and when torn asunder in place of presenting a hackly fracture leaves surfaces with pyramidal cavities and projections.

Analysis.—The iron dissolved very slowly in cold hydrochloric acid attended by the extrication of hydrogen gas, along with which sulphuretted hydrogen was occasionally evolved, as became apparent by passing the gas through a

solution of nitrate of silver. As the solution proceeded the surface of the iron became coated with a brownish flocculent matter, resembling somewhat the development of carbon on steel by nitric acid. These flocculi at length separated from the iron, collected into light coherent masses, and floated about in the liquid, discharging little bubbles of gas and subsiding finally in masses of much-diminished size to the bottom, where they rested upon the broken crystals of the shining white metallic mineral above referred to.

As the solution proceeded very slowly it was repeatedly quickened by a gentle heat for half an hour at a time. Three days elapsed, however, before the action of the hydrochloric acid was completed upon 50 grains of the iron. A second fragment of 20 grains was treated in a similar manner and with the same general result.

Among the insoluble matter from the first fragment were found two very brilliant black octahedral crystals whose weight together was only 0.005 of a grain. They were unmagnetic. Each of them was measured by the reflective goniometer and clearly ascertained to be a regular octahedron. And as chromium was found in the acid solution of the iron it can not perhaps be regarded as an unauthorized assumption to consider these crystals as belonging to the species chromite, the more especially as this mineral has repeatedly been observed in meteorites though never before in well-pronounced crystals.

The brown powder amounted, when dry, to 0.125 of a grain. It was partially acted upon by aqua regia, but in other respects appeared identical with that insoluble ingredient in several meteors which I have called dyslytite and which, besides a decided content of silicon, has iron, nickel, phosphorus, chromium, and carbon in some unknown combination.

The remaining insoluble matter, the white (slightly bronze-colored) crystallized substance, whose weight was 1.05 per cent of the iron, is a mineral which I believe to be undescribed, if not wholly new. It may have been seen before, but if so it would appear to have been confounded with the foliated metallic substance which is also insoluble and which has been called schreibersite by Patera, though this designation can not be maintained inasmuch as I had previously called another meteoric mineral by this name.

I propose the name of *Partschite* for the substance now under consideration in honor of the eminent Prof. Paul Partsch, of Vienna, whose contributions to astrolithology in the description of the meteoric collection of the Imperial Museum at Vienna have been so important to the progress of this interesting branch of knowledge.

Properties of Schreibersite of Patera.	*Properties of Partschite.*
H.=6.6	H.=5.6
Sp. gr.=7.01–7.22	
Magnetic.	Magnetic.
Color bronze-yellow.	Color silver-white, or only with a tinge of reddish gray.
Elastic.	Brittle.
In thin plates.	In four-sided oblique prisms, with dihedral summits, whose faces correspond to the prismatic edges.
	Streak dark gray.
Contains iron, 87.20; nickel, 7.24; phosphorus, 7.26; carbon, ?=98.70.	When powdered, quickly soluble in aqua regia. It contains iron, nickel, magnesium, and phosphorus.

The proportions of the different substances forming the Seneca River meteorite, as ascertained in the two analyses, were as follows:

Nickeliferous iron	98.69
Partschite (with trace of pyrite)	1.05
Dyslytite	0.25
Chromite	0.01
	100.00

The nickeliferous iron gave:

Iron	92.40
Nickel	7.60
Chromium, magnesium, tin, manganese ?, phosphorus, sulphur	traces.
	100.00

Brezina[4] classed the meteorite as a medium octahedrite, and remarked regarding it as follows:

The Vienna specimen permits the recognition of very few details, as the piece is very much weathered. The bands are 0.8 mm. in breadth.

Meunier[5] classed it as caillite and remarked:

This iron gives figures entirely in conformity with the caillite type. The kamacite, tænite, and plessite are relatively normal in structure and medium in amount. There is no pyrrhotine visible.

Brezina,[6] in 1895, also remarked:

A cross section through the whole mass of the Vienna specimen shows octahedral fragments weathered out.

The meteorite is distributed, Vienna possessing 820 grams, and Clinton 450 grams.

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Seneca River. See Seneca Falls.

Sevier County. See Cosby Creek.

SHINGLE SPRINGS.

El Dorado County, California.
Here also El Dorado County and Los Angeles.
Latitude 38° 38′ N., longitude 120° 59′ W.
Iron. Ataxite, Cape iron group, of Brezina.
Found 1869–1870.
Weight, 38.5 kgs. (85 lbs.).

The first mention of this meteorite was by Shepard,[1] as follows:

For my knowledge of the meteoric iron of El Dorado County, I am indebted to Mr. Alfred Stebbins, librarian of the Mercantile Library Association of San Francisco. A letter from him dated April 26 inclosed a few grams of turnings obtained during the separation of a slice of the mass destined for the collection of Professor Whitney.

The mass is described by Mr. Stebbins as having the size and shape of a man's head. It was found in a field, and, as usual, was first taken to a blacksmith's shop, where it was soon found to be an unmanageable subject for working, and hence, fortunately, found its way into scientific hands. Its surface possesses the indentations common to these bodies—the crust or coating being partially oxidized. It weighs 85 pounds.

I find the turnings to have a specific gravity of 7.80, which may perhaps be a trifle above what the mass possesses, as it is presumable that the turnings have suffered a slight condensation in the process of separation.

The fragments sent are free from all traces of sulphur. A single analysis upon one gram has afforded me:

Iron	88.02
Nickel	8.88
Insoluble, consisting of a mixture of $\dot{F}e$ and $\dot{F}e$, with minute silvery particles of supposed phosphor-metals (Schreibersite)	3.50
	100.40

The amount of material at command was too small to search for the other metals commonly found in meteoric irons.

Jackson [2] gave under the name of Los Angeles an analysis of an iron as follows:

Having received from Mr. E. N. Winslow a slice of the recently found meteoric iron of Los Angeles, I have made a chemical analysis of it, which I now communicate to you. The original mass is stated to have weighed 80 pounds. The slice I received weighed 30 grams. Its specific gravity is 7.9053.

It shows when acted upon by dilute nitric acid, innumerable scales of schreibersite, but not the usual figures.

In the chemical analysis I found in the insoluble matter, on reduction by blowpipe, a minute globule of tin. The iron was separated by succinate of ammonia and the nickel by pure potassa.

The following are the results of the analysis:

Metallic iron	80.74
Metallic nickel	15.73
Metallic tin	0.01
Phosphorus and other undetermined matters	3.52
	100.00

This analysis, although not quite complete, shows beyond doubt the meteoric nature of the Los Angeles iron.

Although Jackson gives the name of Los Angeles to this iron and the weight as 80 pounds, there can be little doubt from its composition that the meteorite of Shingle Springs is referred to.

Silliman [2] gave a further account of the meteorite as follows:

An Eldorado meteoric mass was found by the writer in March, 1872, in the cabinet of Mr. W. H. V. Cronise, of San Francisco, where it was placed by its discoverer, Mr. James H. Crossman who, in 1871, rescued it from the forge of a smith at Shingle Springs, California. It was found in 1869 or 1870 in a field belonging to the same smith about half a mile from the town named. It is said to be the first meteoric mass discovered in California.

The mass was intact when I first saw it and weighed about 85 pounds avoirdupois. It was flattened upon one side and presented the usual familiar features of iron meteors. It has since been cut in several sections, one of which (which was exhibited with this communication) shows a cross section measuring 12 by 18 cm. The section is approximately a semicircle, having the flattened side for its diameter, with the outline and exterior coating perfectly preserved on all sides. Its weight was over 800 grams. The largest dimensions of the entire mass were about 24 and 29 cm.

This meteoric mass is remarkably homogeneous in structure and singularly free from the included minerals. Only two very small masses of pyrites, of 3 and 5 mm. diameter, are visible on one side of the slab, and exteriorly I could detect no heterogeneous substance. When the surfaces of the section exhibited were reduced in the planing machine it was observed that the exterior or crust was so much harder than the general surface of the section as to cause the tool to rise a little, thus leaving a distinct margin slightly elevated above the adjacent parts and of a whiter color. This hardened crust had a depth of 4 or 5 mm.

The density of this iron, determined on a mass of over 750 grams in weight, is 7.875, while the density of the shavings cut by the planing tool from the same mass is 8.024, showing a condensation of 0.149 by this mechanical process. This density (of the mass) is above the average specific gravity of meteoric iron, owing probably to its large percentage of nickel, which, as will be observed by reference to the accompanying analysis, is more than twice the average amount of that metal found in other meteoric irons.

The crystalline structure of this mass is obscure. The Widmannstätten figures are not developed on it by etching, although a confused granular structure was evident after this process. Wishing to test this point thoroughly, I consulted Mr. John E. Gavit of the American Bank Note Company, in New York, who is well known for his microscopic and other scientific tastes. Mr. Gavit very kindly tried all the resources known to the engraver's art with a view to develop, by etching this iron, a surface from which its curious cryptocrystalline structure could be transferred to paper by printing. All of these attempts have proved unsuccessful. The etched surface, however, examined with a lens, shows a reticulated structure with numerous brilliant points and V-shaped lines, but so small that when charged with ink the impression upon paper is only a muddy tint. The specimen exhibited shows this peculiar structure developed in four compartments by different etching agents. Some of the printed impressions taken from this surface were also exhibited.

An attempt to develop this cryptocrystalline structure by the aid of a fine "tint" laid on an etching ground by a ruling machine and bitten in, and also by a medallion ruled in orthographic projection, upon which the crystalline lines it was hoped might appear in symmetrical form was not more successful than the other trials. Thus it appears practically hopeless to transfer to paper by printing a structure which may yet be clearly seen by the lens.

The suggestion, made long since by Berzelius, that the Widmannstätten figures were due to the segregation of the nickel alloy in lines of the octahedron which the etching developed, owing to the inferior solubility of the alloy as compared with the pure iron, seems to meet no support from this mass in which the uncommonly high percentage of nickel would naturally lead us to expect a proportionate clear development of the crystalline structure. Is it not rather the probable solution of this structure that it is due to the length of time during which the meteoric mass is kept at a high temperature while slowly cooling? Under such conditions the molecules can rearrange themselves in symmetrical forms and over broad surfaces. In the mass before us it would appear from what has been said of the crust that the heat did not penetrate to a greater depth below the surface than 4 or 5 mm.

The Cape of Good Hope iron analyzed by Uricochoea resembles this both in the absence of Widmannstätten figures and in its high proportion of nickel, but its cobalt is much larger and there are only five elements found, in place of twelve in the California iron.

The following analysis was made upon the clean shavings cut from the entire surface of the section by the planing tool, thus securing a perfectly fair average sample. The analysis was made by Mr. F. A. Cairns, assistant in the School of Mines, Columbia College, whose constant devotion to the analysis of iron gives to his work on this metal great trustworthiness.

Iron	81.480
Nickel	17.173
Cobalt	0.604
Aluminum	0.088
Chromium	0.020
Magnesium	0.010
Calcium	0.163
Carbon	0.071
Silicon	0.032
Phosphorus	0.308
Sulphur	0.012
Potassium	0.026
	99.987

Of the twelve elements quantitatively determined by this analysis, aluminum, calcium, and potassium have been rarely observed in meteoric-iron—meteors free from silicates—while the absence of copper, tin, manganese, and sodium will be noticed.

No room is left, it will be observed, by this analysis for any notable quantity of occluded gases, for which no search was consequently made.

The meteorite was investigated for included gases by Wright[4] who found as follows:

	CO_2	CO	H	N	Volumes
At 500°	19.98	13.52	60.92	5.58	0.65
At red heat	1.10	10.39	84.40	4.11	0.32
	13.64	12.47	68.81	5.08	0.97

The amount of included gases as compared with other meteorites is small.

In 1874 Smith,[5] on account of its high content of nickel, compared Shingle Springs with Kokomo, Cape iron, and Oktibbeha.

Flight[6] stated that etching produces an irregular granular surface which under the glass, on account of numerous small shiny points and lines, appears reticulated. He also, on account of the absence of Widmannstätten figures and the high content of nickel, likens Shingle Springs to the Cape iron.

Brezina[7] in 1893 remarked upon the peculiar elongated bright etching spots which, after etching, come out on the dark groundmass and, despite the irregular edging, show a parallelism of the elongations. He thought that the rhabdite was oriented.

Meunier[8] gave the following note:

The Paris museum has quite a large section of this iron, which shows a very compact metal upon which the acid produces no figures. The presence of nickel is doubtful.

Brezina[9] in 1895 grouped the meteorite among the Chesterville group of hexahedrites and gave the following account of it:

Shingle Springs has a peculiar twofold structure which leans to the ataxites in part. Upon etching there appear in the groundmass elongated, irregularly bordered light etching streaks, whose longitudinal dimensions are parallel; moreover the entire iron is interwoven with numberless small rhabdite laminæ of from 0.1 to 0.2 mm. and occasionally 1.5 mm. in length without definite orientation.

Cohen[11] gave an account of the history of the meteorite, and further studies. The latter are as follows:

A new chemical investigation seemed to me for many reasons desirable. On the one hand the previous analyses vary considerably, and on the other hand Cairns gives a series of constituents which usually occur only in those iron meteorites which include silicates. But on account of the small quantity of silica one could not refer these to the percentages of potash, magnesium, calcium, and aluminum reported. Moreover, the material used by Cairns for analysis (planings) was not free from objection. A section purchased from Ward was employed for an analysis by O. Sjöström. After dissolving a large quantity a small carbonaceous residue remained, but it contained no perceptible quantity of silica. Like negative results were obtained in testing for lime and magnesia in the portions used for the determination of copper. Accordingly, further testing for copper and aluminum seemed to me unnecessary, especially as traces of these elements are difficult to prove if there has been necessity for the employment of a considerable quantity of reagents. Since this was the case in Cairns's analysis, as he employed 10 grams of material, it seemed to me not impossible that the small quantities of Ca, Mg, Al, K, and SiO_2 which he found may have come from the reagents or vessels used or from oils used in the cutting. A test for chlorine by Sjöström gave also a negative result. Sjöström's results were as follows:

Fe	Ni	Co	Cu	Cr	C	P	S	
82.21	16.69	0.65	0.02	0.02	0.03	0.34	0.05	=100.01

This gives the following as the mineralogical composition of the meteorite:

Nickel iron	97.65
Nickel-iron phosphide	2.21
Iron sulphides	.14
	100.00

Thus the results obtained by Sjöström and Cairns differ little, if the abnormal constituents reported by the latter be ignored.

The specific gravity was determined by Dr. W. Leick on a section weighing 11 grams. This was found to be 7.8943 at 21.9° C. The theoretical specific gravity from the constitution of the meteorite would be 7.9215.

Since according to the statement of Silliman the Shingle Springs iron was preserved for a long time in a blacksmith shop, and it is to be supposed that attempts were made to work up the lump, I had Doctor Leick test its magnetic

characteristics. The piece showed polar magnetism, and after magnetization with a strong electromagnet it showed a specific magnetism of 5.7 absolute units per gram, which, considering the unfavorable shape of the section, answers to a pretty considerable permanent magnetism. Therefore, the mass may not have been subjected to a very high degree of heat. As already pointed out by Brezina, the special characteristics of the Shingle Springs iron are the bright etching specks and the great abundance of rhabdite; in addition to this is the high percentage of nickel. These three characteristics are not combined in the same degree in any other meteoric iron.

The rhabdite needles appear to be uniformly distributed throughout the entire iron and are irregularly oriented. By far the greater number are of diminutive size, about 0.03 to 0.07 mm. long and 0.003 to 0.006 mm. thick; a small number attain a length of 1 to 1.5 mm. and a thickness of 0.1 to 0.2 mm., and only one needle was observed 5 mm. in length by 0.15 mm. in thickness. Under a stronger magnifying power many present the appearance of rods bounded by straight lines, others are variously bent, as if they were corroded. Schreibersite is found only in one place in small irregularly formed particles.

The bright, strongly reflecting etching spots are irregularly bounded although mostly elongated and then arranged nearly parallel with the longer axis; on the edge toward the dull portions it often branches out into brushlike ramifications and finally breaks up into small isolated points. There is no gradual transition; the border appears always distinct when the etched surface is examined in the proper position with reference to the direction of the light. Under a stronger magnifying power diminutive strongly reflecting points and streaks may be seen, which are sharply marked off from the surrounding dull ground; they occur in large numbers in the interior of the brighter etching points, but much less abundantly in the darker portions. There may be etch pits present. Therefore, it may be said that by the proper turning of the plate with reference to the direction of the light a position may be found in which the boundaries of the lighter and darker portions entirely disappear. Then the entire section, omitting the rhabdite, appears uniform and perfectly dense; no indication whatever of a granular structure is to be seen even by strong magnifying powers. The existence of a crystalline structure is self-evident, however, when one considers the occurrence of etch pittings which reflect the light in certain positions.

The phenomena observed can only be explained by means of a sort of streaked structure, such that the streaks are less compact and are less readily attacked by the acid than the rest of the nickel iron. Upon the former arise, therefore, more readily and in greater number the etch pittings which occasion the bright sheen in reflected light. The difference in structure by which the different behavior in the presence of different etching agents arises is, however, so insignificant that it can only be detected in this manner.

Both on account of the high percentage of nickel and the occurrence of the etching spots (in places the etching bands), Shingle Springs is closely related with the Cape, Iquique, and Kokomo irons; according to the description of Kunz and Weinschenk, Ternera may also be included here. If no especial weight be given to the kind of edging of the bright portions, this meteoric iron may be included in a well-defined group with the following common characteristics: High percentage of nickel; bright etching bands and spots; dense structure of the nickel iron. Such a grouping appears to me more natural than the division into two groups by Brezina. The latter unites the Cape, Iquique, and Kokomo irons in the Cape iron group, and arranges Shingle Springs and Kokomo under the Chesterville group, which, in consequence of this, acquires quite a heterogenous composition.

The principal portion of the meteorite seems to be lost. Wülfing[10] lists the distribution of only 1,650 grams, of which the Yale collection possesses the largest amount (932 grams). Prof. H. A. Ward has informed the writer that the principal mass fell into the hands of boys shortly after its description by Shepard and was lost.

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Sibley County. See Arlington.

Sierra de las Adargas. See Adargas.

Signet Iron. See Tucson.

SILVER CROWN.

Silver Crown District, Laramie County, Wyoming.
Here also Crow Creek and Laramie County.
Latitude 41° 10′ N., longitude 105° 20′ W.
Iron. Coarse octahedrite (Og) of Brezina.
Found 1887; described 1888.
Weight, 11.6 kgs. (25.6 lbs.).

This iron was first described by Kunz [1] as follows:

The Laramie County mass of meteoric iron was found by Mr. Edward J. Sweet, in the latter part of January, 1887, while he was prospecting in the Silver Crown district almost in the center of township 14, range 70, between the middle and south forks of Crow Creek, Laramie County, Wyoming, about 21 miles west of Cheyenne, in longitude 105° 20′ west of Greenwich and north latitude 41° 10′. When found it was half buried in decomposed granite and earth. After being a ten-days' wonder among the miners at the camp it was sent to Dr. Wilbur C. Knight, of Cheyenne, Wyoming, through whom it came into my possession.

In shape this mass somewhat resembles an anvil. It weighs 25.61 pounds (363 ounces Troy) (11.616 kgs.), and measures 17.5 by 14 by 19 cm. The entire surface is still covered with the original crust of magnetic oxide of iron, which has been slightly acted upon by the atmospheric agencies. No trace of chloride of iron was perceived nor any exudation. The surface is irregularly pitted, the largest of the pittings being 3 by 2 cm. and very deep for their size. No troilite was observed either in the cutting or the pitting. This iron is one of the Braunite group of Meunier. Etching does not produce the Widmannstätten figures but under the glass the markings are seen to be similar to the Braunau Hauptmanndorf iron described by Tschermak and Huntington. This beautiful structure is broken only by the thin layers of schreibersite which divide a surface 25 mm. square into over 25 irregular crystalline parts. The specific gravity is 7.630. The following analysis was kindly made by Mr. H. L. McIlvain:

Fe	Ni	Co	P	C	
91.57	8.31	trace	0.07	trace	=99.95

It approaches more closely to the Rowton, Charlotte, and Jewell Hill meteorites in composition.

Brezina [2] classed the meteorite among the coarse octahedrites and remarked concerning it as follows:

Originally weighing 11.6 kgs., this iron could not have lain long in the ground; the exterior has a tolerably fresh almost black color and shows many pittings, at the bottom of which remains of troilite are sometimes found. Corresponding to this condition there appears upon an etched surface a zone of alteration along the natural exterior measuring some 1.5 to 2 mm. in width, within which the otherwise markedly hatched kamacite has lost this peculiarity and has become shimmering. At certain points where the surface elements project more the thickness of this zone of alteration becomes as much as 7 mm., the inner border of the zone running independent of the inequalities of the outer surface. The bands are straight, grouped, very puffy; tænite slightly developed, conspicuous only in the very scarce fields; kamacite with strongly oriented luster and having deep file marks. There are numerous round or oval nodules of troilite with graphite coverings into which the troilite projects raggedly, outside of which occurs schreibersite, occasionally showing long, straight crystals up to 7 cm. in length. The border is also often of troilite and schreibersite mingled. The kamacite contains many needles of rhabdite.

Cohen [3] found that the iron takes on a more or less permanent magnetism. He also determined the specific gravity not air freed as 7.7793; air free at 16° C., 7.7862.

The meteorite is distributed, Vienna possessing the principal mass, 6,890 grams.

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Smith County. See Carthage.

SMITHLAND.

Livingston County, Kentucky.
Latitude 37° 10′ N., longitude 88° 25′ W.
Iron. Nickel-rich ataxite of Cohen; Braunite (type 3, Sec. 4) of Meunier.
Found 1839–1840; described 1846.
Weight. Large mass of which all but about 4 kgs. (8–10 lbs.) was worked up.

The history and characters of this meteorite were reviewed by Cohen [8] as follows:

During the years 1840 to 1845 Troost [1] obtained several pieces of meteoric iron to test for silver with the information that large masses of the metal were to be had. From Colonel Player, in 1845, he first learned the place of discovery to be Smithland, in Livingston County, Kentucky, and at the same time obtained a piece weighing 2,154 grams besides a cold chisel made of the iron. According to Player the original mass of considerable size had been worked down to some 4 kgs. The iron showed, according to Troost, a fine-grained fracture, the characteristics of steel and no indication of crystalline structure. It was a shapeless mass and had a rough surface, the content of nickel estimated from a partial analysis at some 10 per cent.

Reichenbach [2] called attention to the fact that despite the homogeneous appearance accessory constituents were not entirely lacking; he mentions fine stony bodies and a hollow space produced by the weathering out of sulphide of iron. No Widmannstätten figures are produced by etching; the specific gravity is given as 7.56. If Smithland is to be regarded as meteoric iron, like that of Babbs Mill, it apparently consists of plessite.

Greg [3] made the statement in 1862 that Roscoe in a quantitative analysis had found an unusually high content of nickel, and that by etching no sort of figures came out, but only a few small shiny particles which lay near to one another in tolerably regular interspaces. He compared the iron with that of Rasgata and Green County, more especially with the latter indeed.

G. Rose [4] placed Smithland among those irons the meteoric origin of which he held doubtful.

In 1885 Brezina [6] referred Smithland to the Cape iron group. The groundmass, in which small skeletons or leaflets of schreibersite or rhabdite lie scattered in large numbers, shows by its usually darker color almost exactly similar appearance to that of Kokomo.

He mentions further numerous small troilite inclusions with laminæ of daubréelite and sheaths of schreibersite, as well as a thin crust resembling the usual fusion crust. In 1895 Brezina [7] identified the iron with the Babbs Mill group which embraced very heterogeneous things.

According to Meunier [5] the iron was absolutely identical with the Cape iron.

My study was on a piece of about 100 grams weight with one section surface of 14 sq. cm. This had the other rounded bounding surfaces covered with a thin, for the most part somewhat oxidized fusion crust. After weak etching the polished surface takes on a peculiar sheen like that of a thin coat of varnish. The accessory ingredients come out very distinctly and, as Brezina has already noted, consist of troilite, schreibersite, and daubréelite, all in this case of insignificant dimensions. The largest single individual troilite has a length of 1.8 mm. and a breadth of 0.4 mm, but the greater number are only 1/30 as large and many are so small as only to be distinctly seen under the microscope. All are of elongated form; a few run to a point at one end and are blunt at the other so that hemimorphic forms result, as in the Cape iron. One of the largest troilites incloses a daubréelite plate 0.25 mm. in width which is perpendicular to the long diameter and, therefore, indeed as in other iron meteorites, oriented parallel to the base; on a few places besides large grains of 0.05 to 0.15 mm. occur in isolated heaps. Most of the troilites are bordered with a narrow zone of schreibersite, the breadth of which, according to the size of the former amounts to between 0.02 and 0.08 mm.; in reflected light under the microscope the schreibersite distinguishes itself from the troilite, in the case of very small inclusions, by the color and luster. Moreover rhabdite occurs in small needles which occasionally arrange themselves in star-shaped groups.

The schreibersites borders do not show more distinctly by longer etching, the varnishlike luster fades, the polished surface takes on a dark ash-gray color and becomes dull but attains a homogeneous appearance. Under the microscope with higher powers only small regularly arranged points which reflect the light show themselves, but one sees neither etched pittings nor any indication of granular structure as may be seen with like magnifying powers, for instance in the case of Babbs Mill, to which in other respects it has great similarity.

Analysis by Sjöström:

Fe	Ni	Co	P	S	Cr	
82.83	16.42	0.94	0.09	0.17	0.06	=100.51

Mineralogical composition:

Nickel iron	99.00
Schreibersite	0.58
Troilite	0.27
Daubréelite	0.15
	100.00

Specific gravity of 97.47 grams at 13.4° C. (Dr. W. Leick) 7.7115.

This meteoric iron shows polar magnetism and gives a specific magnetism after magnetizing to "saturation," of 4.05 per gram.

According to composition and structure, Smithland stands next to Babbs Mill, although it is also of somewhat finer structure. It partakes with Morradal the varnish-like luster, but distinguishes itself from the same by the absence of the dark grains and spindle-like shape.

The meteorite is distributed, the British Museum (2,556 grams) and Harvard (1,877 grams) possessing the largest pieces. As Troost mentions only 2.1 kgs. and collections report over 5 kgs. other masses must have been obtained.

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SMITHS MOUNTAIN.

Rockingham County, North Carolina.
Here also Rockingham County.
Latitude 36° 30′ N., longitude 79° 5′ W.
Iron. Fine octahedrite (Of) of Brezina.
Found 1863; mentioned 1872.
Weight, 5 kgs. (11 lbs.).

This meteorite was first mentioned by Tschermak[1] in his catalogue of 1872 as an octahedrite with medium lamellæ.

Smith[2] stated in 1874 that he had found a small green mass of solid lawrencite and had tested it qualitatively.

In 1875 Kerr[3] gave the history of the meteorite as follows:

Mr. W. C. Kerr, State geologist of North Carolina, obtained this meteorite in 1866 from a Mr. Peters, who found it a few years earlier, and who lived near the point where it was picked up.

It was found in an old field which had not been cultivated for 20 years, on top of a high hill—Smiths Mountain—and near the site of a former dwelling, so that its fall probably occurred within 20 years of its discovery.

The mass is very compact and almost as hard as steel. The original weight was within 1 ounce of 11 pounds. It was coated with rust.

Analysis (Genth):

Fe	Ni+Co	P–Ni–Fe	Cu	
90.41	8.74	0.14–0.33–0.27	0.11	=99.97

It consists of a mixture of several iron-nickel alloys, intermixed with phosphide of nickel iron. The iron contains pyrites, and probably quartz or a silicate in minute quantity.

This meteoric iron is undoubtedly one of the most interesting in existence. Genth also notes the presence of chloride of iron.

Its structure is highly crystalline, and when polished or etched develops remarkably fine Widmannstätten figures with delicate markings on the inside of the figures. Smith likewise discovered chloride of iron in this meteorite.

Smith[4] gave a nearly similar account as follows:

This meteorite was first brought to my notice in 1870 by Prof. W. E. Kerr, the geologist of the State of North Carolina; but a short time afterwards, seeing a notice of it by Doctor Genth in the Proceedings of the Academy of Sciences of Philadelphia, and as he proposed giving a further description of the same at some future time, I laid aside my notes concerning it; but having frequently been asked for particulars in relation to it from those possessing specimens, I have concluded to publish the notes made at the time it came into my possession.

This iron was discovered in Rockingham County, North Carolina, on a spot known as Smiths Mountain, 2 miles north of the town of Madison, about latitude 36° 20′, longitude 79° 45′. It was found by a Mr. Peters, from whom Professor Kerr obtained it about the year 1863, and was lying on the surface of an old field which had been out of cultivation less than 20 years, and for that reason is supposed to have fallen within that period.

It weighed originally about 11 pounds, and was covered with a coating of rust. Its structure is highly crystalline, and when polished and either heated or acted on by nitric acid furnishes remarkably fine Widmannstätten figures with delicate markings on the inside of the figures, which I designated some time ago as Laphamite markings, having first observed them on the Wisconsin iron.

This iron contains narrow seams of schreibersite that penetrate the mass for several centimeters in different directions, some of them being 2 or 3 mm. in thickness. In one part of the iron I discovered some solid chloride of that metal, enough to test its nature, and I detached a small fragment that is now in the museum of the Garden of Plants, at Paris. It attracted moisture after having been taken from a crevice in the iron, and became quite soft. This is the second time I have observed this solid chloride in meteoric iron.

The nickeliferous iron, constituting the mass, exhibits the characteristics common to iron meteorites, viz, more or less diversity in the character of the iron in different parts, these varieties being so intimately associated that we possess no means of separating them. Doctor Genth considers it as composed of three different kinds of iron. I selected a fragment perfectly free from any schreibersite visible to the eye; it gave a specific gravity of 7.78, and on analysis was found to contain:

Fe	Ni	Co	Cu	P	
90.88	8.02	0.50	0.03	0.03	=99.46.

This will seem to correspond to the analysis by Doctor Genth before referred to.

Brezina,[5] in 1885, made the meteorite the type of a subdivision of the fine octahedrites, stating its characters as follows:

Bands isolated, straight, very puffy, 0.25 mm. wide. Fields predominant, quite filled with a felt of fine branching twigs. Large troilite inclusions.

In 1895 he[8] changed his opinion regarding the troilite inclusions, stating that they were "schreibersite, surrounded by swathing kamacite 1 mm. in breadth, with troilite nodules."

Cohen[9] described the structure of the iron as follows:

The long, straight lamellæ are not grouped; occasionally several lie quite close together, but they are still separated by very small plessite strips. The borders of the larger lamellæ are sometimes straight, sometimes wavy, while the smaller are mostly puffy. The fields predominate and are quite uniformly distributed, tænite is distinctly visible. The kamacite is much hatched and shows a somewhat fibrous aspect. Under a higher magnifying power it appears fine-granular between the etching lines. This structure seems like etching pits but may indeed be dust-like inclusions. The predominating fields measuring up to 10 sq. mm. show without exception, and in the most perfect manner, a structure which in appearance resembles exactly the micropegmatitic structure of terrestrial rocks. It is much larger and finer here and, therefore, better developed than in the case of Jewell Hill. Fine-grained, dark plessite, with tiny, glistening spangles forms a compact groundmass, which is so evenly interwoven with tænite that it appears upon the section surface in thread-like filaments of very various forms. The tænite apparently forms an individual and plays the rôle of the quartz in pegmatite. Whether, however, the plessite is like feldspar, an individual or a very fine-grained composition, must remain uncertain. Still the latter seems to me more probable considering the formation which such plessite usually shows. The small, elongated fields crowded between the lamellæ are scarcely noticeable even under the glass, and are filled with black, compact plessite, which, however, on greater magnification, also appears finely granular, and is distinguished from the groundmass of the larger fields merely by its finer grain. Occasionally these small fields are crossed by one or more fine lamellæ which reach from side to side.

Schreibersite occurs on the one hand in small grains within the bands and on the other hand in large crystals, surrounded with swathing kamacite, with inclusions and indentations of nickel-iron. In the neighborhood of rifts following the lamellæ from the surface inward occur large numbers of small round particles of iron-glass (sections of spheres), filling many bands pretty compactly. There is no troilite in the section which I have.

The meteorite is chiefly preserved in the State Museum at Raleigh, North Carolina.

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SMITHVILLE.

Dekalb County, Tennessee.
Here also Caryfort, Cany Fork, and Caney Fork.
Latitude 35° 56′ N., longitude 85° 48′ W.
Iron. Coarse octahedrite (Og), of Brezina; Arvaite (type 7), of Meunier.
Found 1840; described 1845.
Weight of mass found in 1840, 16 kgs. (36 lbs.). In 1893, three more masses of 30, 7 and 3 kgs. (65, 15 and 7 lbs.) were found, and in 1903 two of 3.4 and .5 kgs. (8 and 1 lbs.).

The first mention of this meteorite was by Troost.[1] He mentions a meteoric iron found a few miles west of Canyfork, Dekalb County, Tennessee. He states that it had a smooth, glossy surface and was of an oval shape, its longer diameter being from 10 to 12 inches. Five years later he described the mass which he says was found in Dekalb County, Tennessee, a few miles west of Cany Fork, near the road from Liberty to the ferry on that river, as follows:

Only one piece of it was discovered. Its weight when it came into my possession was about 36 pounds. Its original weight must have been greater, as several chips had been cut from the surface, by which the blacksmiths and silversmiths found out that it was not gold or silver.

When I first saw the mass, it had an ochery-brown glossy surface, but the least scraping with an iron tool brought the natural iron color to light, so that it was not covered with a crust. It had an irregular oval shape.

This iron is remarkable for its Widmannstätten or crystalline figures, which are handsomely displayed on the section without its being subjected to any chemical operation. These figures are shown on the polished surface by the section of laminæ, which are embedded through the whole mass of iron. These lamellæ are easily distinguished from the rest of the mass by their color, which is almost silver-white; they are harder and receive a brighter polish than the bulk of the mass. When these lamellæ are cut parallel to their planes, or nearly so, they exhibit only irregular spots, but when they are cut transversely, though irregularly dispersed through the iron, they exhibit a regular arrangement. They are all inclined toward each other in such manner that if they were extended till they met at the extremities, they would form equilateral triangles, so they that indicate the crystalline structure of the mass, which is that of octahedrons. In this respect it coincides with the Cocke County iron. The latter being more or less subject to decomposition, I was able to separate several of these lamellæ, which have almost the color and luster of burnished silver, and are not yet tarnished, though they have been exposed for 5 or 6 years to the influence of the atmospheric air.

There is no doubt that these pellicles, or lamellæ, though equally attracted by the magnet, have a different composition from other parts of the iron, and this seems to be the cause that the several analyses made of the same iron seldom give the same result.

The polished section of my cabinet specimen offers a surface of about 7 by 4.5 inches; it exhibits in this space two large heterogeneous masses, one of about 0.8 inch and the other about two-thirds of an inch in diameter, and others smaller. I consider these masses as composed principally of graphite, intimately mixed with metallic iron, as the powder which I scraped off is feebly attracted by the magnet, and soils paper like common plumbago, and its streak has a black metallic luster. In this respect, also, it resembles the Cocke County iron. Upon the whole, it is an interesting variety.

The locality near Liberty, where Troost states his specimen was discovered, is about 10 miles from Smithville.

Huntington [5] described the structural features as follows:

Another striking octahedral mass is a fragment of the well-known Dekalb County meteorite. One specimen of this iron shows hollow octahedral faces 2 inches in diameter, like hopper crystals, consisting of skeletons built up of a series of plates about half an inch wide and one-sixteenth of an inch thick. These plates when cut transversely constitute the Widmannstätten figures. When the section is cut at random the figures may differ somewhat in character and the plates appear to make various angles with each other; but when the etched surface is parallel to an octahedral face, the Widmannstätten figures all make equilateral trinagles, their sides being parallel to the octahedral edges.

In 1892 three other masses were found at Smithville and described by Huntington [8] as follows:

In the early part of last summer Mr. Herman Meyer sold three new masses of meteoric iron from Smithville, Dekalb County, Tennessee, to Professor Ward, of Rochester, New York. After the largest mass had been sawed into slices these were kindly sent by Professor Ward to the writer for examination and with it was sent the following letter describing the find:

"Three siderites weighing about 7, 15, and 65 pounds each.

"In November, 1892, Mr. John D. Whaley plowed up the medium-sized meteorite (15 pounds). In a few days thereafter Mr. Berry Cantrell, on the adjoining farm of Mr. James Beckwith, plowed up the large one (65 pounds) at about 200 feet from the first one. These meteorites were carefully kept in the families of their respective finders.

During December, after diligent search of some weeks, the third and smallest (7 pounds) was discovered and kept in the family of J. D. Whaley.

"During the spring plowing of 1893 a very thorough search of the whole region was made without further finds. The spot where these three pieces were found is three-eighths of a mile south from the Smithville and Lebanon pike, in an extreme southwest field of J. D. Whaley and the adjoining field of James Beckwith. Herman Meyer, the purchaser of all these, satisfied himself that the meteorites were original and distinct, and that all was as represented.

"This locality is about 40 miles southwest from the spot on Caney Fork where the Carthage meteorite was found."

There is no question that the irons were found as stated in the above letter; but the Cocke County iron has a very close resemblance to the Smithville meteorites.

The largest mass of the Smithville iron is roughly spherical, with no signs of original crust, but marked by one deep pitting which once contained troilite, now nearly weathered away, or possibly fused out during its flight through the atmosphere. The specimen had laid for a long time in the soil, as shown by the thick coating of magnetic oxide of iron strong enough to attract iron nails with considerable force. This covering, however, does not fully conceal certain very typical features of the iron—a marked silvery whiteness, a very striking and nearly octahedral cleavage, a slightly yellowish metallic foil separating the crystalline flakes of iron; also numerous nodules of very cleavable troilite embedded in graphite and granular schreibersite; while perhaps the most striking feature of all is a nodule of fine-grained compact graphite nearly 2 inches in diameter. This is probably a larger mass of meteoric graphite than any other on record. The only one to compare with it is that described by J. L. Smith in the Sevier County iron. The weight of the Smithville nodule can not be accurately estimated, as it was not observed until the mass had been sawed into slabs. It appeared to be nearly spherical, with a diameter as great as the largest dimension of the dumb-bell-shaped nodule described by Smith, making the total mass of the former considerably greater than that of the latter.

Nodules of graphite and troilite are abundantly scattered over the surface of an etched plate 9 by 7 inches in size, usually consisting of troilite embedded in graphite, and thus surrounded by schreibersite, although there is considerable variety in the relative arrangement of these three minerals in the individual nodules. In places the schreibersite widens out into bright patches between the Widmannstätten plates, especially in proximity to the troilite nodules.

This inequality in the distribution of the schreibersite gives a very varied appearance to the etched surface, and areas selected from opposite ends of the slab could not possibly be identified by the Widmannstätten figures above. In this respect the iron very closely resembles those of Arva and Sarepta.

Choosing as uniform material as possible, the average analysis gave:

Fe	Ni	Co	Cu	P	Residue (cliftonite)	
91.57	7.02	0.62	trace	0.18	0.15	=99.54

Huntington [8] gives analyses of other irons which resemble Smithville and then states:

After dissolving a portion of the iron in hydrochloric acid, assisted by a battery, a black residue was obtained consisting mainly of small graphitic crystals with a predominance of cubo-octahedral forms, but showing also perfect little cubes without any modifications and others with their edges truncated by the dodecahedron and occasionally beveled by a very obtuse tetrabis-hexahedron.

This he regards as the form of graphite named cliftonite by Fletcher.

With the cliftonite Huntington states were also to be seen numerous white glassy grains. On digesting the residue for a long time with hydrofluoric acid most of the white grains disappeared, but a few remained entirely unaffected by the acid. These appeared as very brilliant transparent angular fragments and exhibited a hardness sufficient to scratch the ruby. Huntington regards these grains as probably diamond. He also quotes a statement of Professor Ward to the effect that the iron was very difficult to cut as a further indication that it contained diamond. Huntington considers further the probability that Smithville and Cocke County may be the same meteorite and reaches an affirmative conclusion on account of the great quantity of Cocke County reported.

On this point, however, later investigators will be more inclined to agree with Glenn,[10] who wrote as follows:

Three pieces of meteoric iron from Smithville, Tennessee, are mentioned by Huntington in his description of that fall. A fourth piece was sent to the United States National Museum. During the year 1903 two additional pieces came into my possession. They were found about 40 years ago at Berry Cantrell's, 1 mile west of Smithville, Tennessee. The larger mass weighed 3,460 grams and was of compact rounded shape and evidently entire. The smaller weighed 478 grams and had a portion removed by some one. The character of the masses was similar to that described by Huntington, and, although the place where they were found was not just the same as that from which the previously reported masses came, they all belong undoubtedly to the same fall, which may have been scattered over a considerable area. Huntington's suggestion of collusion in these Smithville finds and his regarding them as being really part of the Cocke County iron do not seem to accord with the circumstances. No object can be discerned in anyone's

going to the trouble of securing portions of a fall, carrying them several hundred miles across the mountains, secreting them 40 or 50 years, and then making presents of them to strangers! The only reasonable conclusion is that the Smithville finds fell near Smithville and not in a far-distant corner of the State.

Smith [4] reported—

Carbon of the character of graphite, filling irregular ovoidal cavities, like troilite, and more or less contaminated with the latter mineral, are observed in this meteorite. The conversion of this meteoric graphite into graphitic oxide was more rapid than that of any terrestrial graphite with which I have experimented.

Brezina [4,9] made several observations upon different masses or sections of Smithville, as follows:

Kamacite plates 1.5 to 3 mm. in diameter have in almost every case a rib of porous schreibersite, a small quantity of tænite and plessite, the latter of a dark-gray color. Two trolite inclusions of some 3 to 4 mm. diameter have each a patch of schreibersite 1.5 to 2 mm. broad, around which is an irregular envelope of kamacite.

* * * * * * * * *

This meteorite is an intermediate member of the group Og. It has an oriented luster, but very slight "file marks," on which account the kamacite shows at first very granular. Bands are 1.5 mm. in size.

* * * * * * * * *

Under Smithville are united the irons described as Caney Fork, Caryfort (erroneously given as Caney Fork), and Smithville, which agree perfectly among themselves, except for their state of preservation, of which the iron found in the year 1840 is a good example, while that found in the year 1892 is decomposed throughout its entire mass. A large section of this iron, a cross section of the entire mass, shows three still preserved nodules and the remains of a fourth. One of these nodules shows polyhedral boundaries and is composed of troilite, with a seam of graphite 0.5 mm. thick, and a very faint corona of schreibersite; the second consists of graphite with an envelope of troilite 0.1 to 1 mm. thick and a crown 1 to 2 mm. thick; the third consists of two-thirds troilite and one-third graphite with a zone of troilite and an envelope of graphite 0.5 mm. thick, besides a widely radiating corona of schreibersite.

Meunier [7] remarked regarding it as follows:

The general characteristics of the arvaite type are exhibited in this iron with the greatest distinctness. Merely by polishing the iron shows a geometrical network of bands consisting of schreibersite, and here and there very angular bundles of the same phosphuret, more or less completely enveloped with graphite. The Widmannstätten figures are very like those of the Brazos iron. The kamacite has practically the same form; yet a great abundance of tænite is noticeable, which not only forms the filaments between the elements of the preceding alloy, but also constitutes the grills in the triangular and rhombic intervals between them.

The Smithville meteorite is distributed, Harvard and Ward possessing the largest pieces.

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STAUNTON.

Augusta County, Virginia.
Here also Augusta County.
Latitude 38° 14′ N., longitude 79° 1″ W.
Iron. Medium octahedrite (Om), of Brezina; Caillite (type 18), of Meunier.
Found 1858 or 1859; described 1871.
Weight, 121,614 grams (270 lbs.), divided among six masses which have the following weights: No. 1, 25,429 grams; No. 2, 16,441 grams; No. 3, 1,644 grams; No. 4, 68,950 grams; No. 5, not stated, but dimensions indicate about 2,000 grams; and No. 6, 7,150 grams. Brezina[10] separated the fourth mass, found in 1858 and described in 1878, from the remaining masses on account of its differences of structure. In his statement, however, that it is from an unknown locality, he is not corroborated by the original description.

The first three masses of this iron were described by Mallet,[1] as follows:

Nearly two years ago I learned that a lump of iron, which, from the description given of it, I supposed to be meteoric, had been turned up by the plow in Augusta County, in this State, and soon afterwards I obtained possession of this specimen by the kind assistance of Hon. J. B. Baldwin, of Staunton. It proved to be beyond question a meteorite, weighing about 56 pounds. A few months later I saw at the annual fair of the State Agricultural Society, in Richmond, a second mass of smaller size, weighing about 36 pounds, which had come from the same county and was exhibited along with some iron ores by Maj. Jed Hotchkiss, of Staunton. Learning from me that I was about to examine and analyze my own specimen, and was anxious to compare it with the other found in the same part of the country, Maj. Hotchkiss was obliging enough to lend me the latter and to permit me to cut off enough for analysis.

Quite recently, he has placed in my hands a third specimen, also from Augusta County, weighing but about 3.5 pounds. I shall speak of these three masses as No. 1, No. 2, and No. 3, in the order in which they are mentioned above, No. 1 being my own specimen and Nos. 2 and 3 those of Maj. Hotchkiss.

All three present quite the same general appearance. They are of a very irregular pear shape, one end of each mass being larger and more rounded than the other. The smaller end of each is somewhat flattened, but by concave surfaces, in one direction. No. 1 was more massive and rounded than the others; No. 2 was the most flattened, having some rude resemblance in shape to a shoulder of mutton. The dimensions of the masses before cutting were as follows:

	No. 1.	No. 2.	No. 3.
Maximum length	28 cm.	27 cm.	11 cm.
Maximum width, at large end	21 cm.	10 cm.	9 cm.
Maximum width, at small end	17 cm.	19 cm.	5 cm.
Maximum thickness, at large end	13 cm.	13 cm.	8 cm.
Maximum thickness, at small end	11 cm.	5 cm.	3 cm.

The exact weights before cutting were: No. 1, 25,429 grams; No. 2, 16,441 grams; No. 3, 1,644 grams; the masses being entire, nothing having been previously detached from any one of them.

The surface of each of the masses is rough and irregular. At some points, which have been rubbed, the iron exhibits its metallic luster, and traces of its crystalline character may be observed, but nearly the whole surface is covered with a dark-brown crust, consisting essentially of hydrated ferric oxide, which varies from about an eighth to a third of an inch in thickness. This crust is hard and pretty firmly adherent. On exposure to moist air a rusty liquid exudes in drops from numerous points on the surface, and in this watery liquid, chlorine, iron (chiefly as ferrous chloride), and nickel were detected. The masses are, of course, magnetic, and on examination give evidence of feeble magnetic polarity, with multiple poles.

The union of hardness and toughness in the iron makes it quite difficult to cut, and in attempting to obtain, with the planing machine, a slice of considerable size the ordinary cutting tools were blunted and broken. It was found necessary to drill a row of holes and connect these by a cut made with the planer.

The specific gravity was taken for Nos. 1 and 2 with solid pieces of about 140 grams and 0.95 grams, respectively, cut from the interior of the masses, and for No. 3 with about 10 grams of clean shavings (from the planer) in a specific-gravity bottle. The results were:

	No. 1	No. 2	No. 3
Specific gravity at 15° C.	7.853	7.855	7.839

The interior structure of the iron is compact and highly crystalline, of much the same general character throughout, but a few small grains and streaks of a brownish-yellow mineral were noticed, which on being picked out and examined proved to be troilite. There are, however, minute fissures running through several portions of the metal.

Traces of the Widmannstätten figures may be detected upon a polished surface even without the aid of acid, and when the iron has been etched by nitric acid the markings are exceedingly beautiful and distinct. The general appearance is a good deal like that of the iron from Lenarto in Hungary and some of the Mexican specimens. In the mass

No. 1, upon the principal cut surface, narrow well-defined bands of alternate nickel iron and schreibersite are parallel to or intersect each other at angles of about 60° and 120°; in the figures on the principal surface of No 2 the angles of intersection more nearly approach 90°; on the much smaller cut surface of No. 3 the figures are somewhat more irregular but the angles approach 60°. By etching surfaces obtained in other planes it was rendered evident that the difference of appearance is merely due to looking at different projections of the same crystalline structure.

The metal soon rusts upon cut surfaces, especially where the exudation of chlorine occurs, and this renders more distinctly visible the slight fissures which penetrate the interior.

The iron is not passive, though very easily rendered so by nitric acid. It reduces copper rather slowly from the sulphate, and if the whole surface be covered by the latter metal and then washed under a stream of water, rubbing hard with the hand or a cloth, a part of the copper comes off very easily, leaving the remainder very firmly attached and reproducing very beautifully the Widmannstätten figures; obviously a case of galvanic deposition, the schreibersite being the electronegative solid and receiving the coating of copper. By the prolonged action of acid delicate white laminæ of schreibersite are brought into view, which if completely detached are found flexible and strongly magnetic.

The following are the results of chemical analysis:

	Fe	Ni	Co	Cu	Sn	Mn	P	S	Cl	C	Si	
No. 1.....	88.706	10.163	0.396	0.003	0.002	trace	0.341	0.019	0.003	0.172	0.067	=99.872
No. 2.....	88.365	10.242	0.428	0.004	0.002	.....	0.362	0.008	0.002	0.185	0.061	=99.659
No. 3.....	89.007	9.964	0.387	0.003	0.003	trace	0.375	0.026	0.004	0.122	0.056	=99.947

These numbers are so closely accordant that there can be no doubt of the masses being essentially identical in chemical composition. The nickel and iron were separated in a cold and quite dilute solution by means of carbonate of baryta, and the precipitates obtained were carefully tested as to purity before the weights were finally accepted as correct. Considerable quantities of material were used for the determination of the minor constituents. Particular attention was given to the identification of the minute quantity of tin present, as Prof. J. Lawrence Smith has lately mentioned the fact that he has never found this metal in the course of numerous analyses of meteoric iron. The precipitate with sulphureted hydrogen, which contained the tin and the copper, was in each case obtained from a solution of more than a hundred grams of the iron. I feel satisfied that the chlorine is not of meteoric origin—not an essential constituent of the original masses—but has been derived from the soil in which the iron has lain embedded.

The exudation of watery drops containing metallic chlorides is observable only at points on the outside and on cut surfaces along the lines of fissures communicating with the outside. Although chlorine is mentioned above as found in the general analysis of the planing-machine shavings, I failed altogether to detect it in a specially selected solid piece taken from a part of No. 1 destitute of fissures or flaws.

The siliceous residue is set down as silicic acid, but some of it seems to have in reality existed as silicide of iron. A part of this residue having been examined with the plowpipe to identify it as silicic acid, another portion was looked at with a magnifying power of 250 to 500 diameters, and in polarized light it was seen to consist of an amorphous powder and rounded transparent grains of very small dimensions, for the most part from 0.0025 to 0.0100 mm. in diameter of well-marked doubly-refracting character.

It seems in the highest degree probable that these three masses represent portions of a single fall from the heavens, agreeing so closely as they do in external character and appearance, in density and internal structure, and in chemical constitution, having all been found, moreover, at but short distances from each other. The precise localities from which they came are as follows:

No. 1, from a spot on the land of Mr. Robert Van Lear, about 5 miles (a little east of) north from Staunton, latitude 38° 14′ N., and longitude 79° 1′ W.

No. 2, from the land of Mr. M. Fackler, about 1 mile to the southeast of the locality of No. 1.

No. 3, about half a mile still farther southeast, or rather a little north of a northwest and southeast line passing through the last-named locality.

It will be interesting to watch for the possible detection of other masses in the same neighborhood.

The next year Mallet[2] made a determination of the gases from the meteorites as follows:

Analysis of gases occluded in Augusta County meteorite:

	Portion A	Portion B	Portion C	Total
Hydrogen.....	22.12	10.52	3.19	35.83
Carbonic oxide.....	15.99	11.12	11.22	38.33
Carbonic anhydride.....	7.85	1.02	0.88	9.75
Nitrogen.....	6.06	1.45	8.58	16.09
	52.02	24.11	23.87	100.00

Careful analysis of the gas yielded the above results by volume for the three portions separately collected. The fourth column of figures, obtained by summing up the three which precede it, gives the percentage composition of the whole of the gaseous matter extracted from the iron.

Other gases were tested for but none could be found. No free oxygen could be detected nor any compound of oxygen and hydrogen.

As to the nature and amount of the constituent gases, the results differ very materially from those arrived at by Graham, as may be seen by the following comparison:

	Lenarto	Augusta County
Hydrogen	85.68	35.83
Carbonic oxide	4.46	38.33
Carbonic anhydride	-----	9.75
Nitrogen	9.86	16.09
	100.00	100.00

The gases obtained in the experiment now in question agree more nearly with those of common wrought iron (clean horseshoe nails), as found by Graham, viz., in the first portion collected:

Hydrogen	35.00
Carbonic oxide	50.3
Carbonic anhydride	7.7
Nitrogen	16.09
	100.00

and the conclusion arrived at by him, that "the predominance of carbonic oxide in its occluded gases appears to attest the telluric origin of iron," would deny to the Virginia specimen the right to be classed among meteoric masses, with which, however, all its other physical and chemical characteristics agree most fully. I am quite satisfied, from the condition of the masses of iron as they came into my hands, and especially from the character of the crust, that the metal had not been subjected to any heating in a blacksmith's fire or otherwise by human hands since it was found, as has sometimes happened to similar specimens in the endeavor to discover their nature or to make use of them.

A fourth mass was described by Mallet [3] in 1878, as follows:

In 1871 I described three masses of meteoric iron found a few miles from Staunton, in this State; still another has lately been brought to light under the following circumstances: About the year 1858 or 1859 a negro man, named Alf, belonging to Mr. Robert Van Lear (on whose land the largest of the three already described meteorites was found), brought to Staunton a lump of iron which he had found, and tried to sell it, but no one considered it curious or valuable enough to pay the price asked, a dollar. This man is dead, and it can not now be ascertained where he found the specimen, but probably on Mr. Van Lear's land, and undoubtedly in his immediate neighborhood. Failing to sell the mass, Alf threw it away in a vacant plot of ground behind a blacksmith's shop. Here it lay for several years, until it was used, with some other loose material to build a stone fence. On account of its irregular shape and great weight it soon fell out of the fence, and was then thrown aside in the rear of a dentist's house. He used it for some time as an anvil on which to hammer metals and crack nuts, and afterwards had it built into a wall round the curbing of a cistern. Here, during the summer of 1877, it came under the notice of Mr. M. A. Miller, of Staunton, who obtained possession of it, had it removed from the wall, and near the end of the year disposed of it to Messrs. Ward and Howell, of Rochester, New York. These gentlemen, who were at the time engaged in the arrangement of a geological and zoological collection which they had contracted to furnish for the University of Virginia, allowed me to examine the meteorite before it was sent to Rochester, and have furnished me with material for its analysis. They are having the largest part of the iron cut into slices as specimens for sale.

The shape of the mass is like that of many other metallic meteorites, irregularly rounded, larger at one end than the other, something like a shoulder of mutton in general outline, with well-marked concave depressions or pittings.

The greatest length is 45.7 cm., greatest width 29.2 cm., and greatest thickness 20.3 cm. The weight was 152 pounds, or 68,950 grams. The crust was not as thick as that upon the masses from the same locality previously examined, and at a number of points the metallic luster of the iron was visible. Magnetic polarity was detectable at various parts of the surface. The specific gravity, taken with a clean piece of 87.5 grams, was found =7.688 at 18° C. The iron is compact and crystalline, with plates of schreibersite running through it, while a few specks of troilite were detected. On etching with nitric acid the Widmannstätten figures are clearly and beautifully brought out, and their general character is quite the same with that shown upon the etched surface of the three previously described masses. On one surface two distinct sets of crystalline markings are observable, the angles of intersection in each of these being nearly uniform.

An analysis made by Mr. J. R. Santos, of Guayaquil, Ecuador, now working in this laboratory, gave the following results:

Iron	91.439
Nickel	7.559
Cobalt	0.608
Copper	0.021
Tin	trace
Phosphorus	0.068
Sulphur	0.018
Chlorine	trace
Carbon	0.142
Silicon (counted as silica)	0.108
	99.963

The chlorine occurs as ferrous chloride, soluble in water; 87.5 grams of iron was used for analysis, so as to render accurate the determination of the minor constituents. A partial examination of another specimen, however, showed that, as usual in such masses, the distribution of the schreibersite, and probably the nickel in the alloy, is not altogether uniform. The average amount of nickel is somewhat less than in the three formerly described masses, and the proportion of cobalt and copper rather larger; but there can be no doubt, I think, that all four specimens, found in the same neighborhood, resembling each other closely in all their physical properties, and exhibiting the same general chemical character, represent different portions of the same meteoric fall.

In 1880, Brezina [4] noted the occurrence of Reichenbach lamellæ in etched sections of the meteorite and figured them. In 1885 he [5] grouped Staunton as an octahedrite with medium lamellæ, the characteristics of the group being as follows:

Lamellæ puffy, not bunched, oriented sheen prominent, hatching very fine, and therefore not very prominent; fields and combs abundant; plessite dark.

Kunz,[6] in 1887, described a fifth mass as follows:

This mass of meteoric iron was given to the late Col. W. B. Baldwin, of Staunton, Augusta County, Virginia, and was found at or near the place where the largest of the three masses from Augusta County, first described by Professor Mallet, was found. Colonel Baldwin was under the impression that it was a detached part of the largest mass. Professor Mallet received it from him at a considerably later date than the large mass and having chipped and filed a small flat surface, he found, after etching, that the Widmannstätten figures were like those on the large mass. A careful examination satisfied him that this piece of iron had not been in any way artificially detached from any of the previously discovered masses, though there is no doubt that all the other four meteoric irons from Augusta County, including the one now described, are portions of a meteorite which probably exploded in mid air. Its present dimensions are 8.5 cm. by 6.5 cm., 7 cm. at the widest end and 3 cm. at the smaller end. This, like the other masses, contains ferrous chloride which, by its deliquescency, has caused much of the mass to exfoliate and crack off, so that it is only a nodular remnant of what was once a much larger mass. At one end there is a large fragment weighing several hundred grams, which is in part separated by a fissure 4 mm. wide, a result of oxidation. Several fractures show from four to six faces of the octahedron. The following analysis of the mass is kindly furnished by Prof. J. W. Mallet:

Fe	Ni	Co	Cu	Sn	Mn	Cr	P	S	Cl	C	Si	
90.293	8.848	0.486	0.016	0.005	trace	trace	0.243	0.012	trace	0.177	0.092	=100.72

Kunz does not give the weight of the mass, but the dimensions given indicate a weight of about 2,000 grams.

Cohen and Weinschenk [7] obtained the following on decomposing 31.755 grams of the outer portion of the meteorite:

	Grams.	Per cent.
Nickel iron	23.3032	73.38
Jagged fragments	5.0433	15.88
Tænite	1.0116	3.19
Schreibersite	0.1293	0.41
Rust	2.2676	7.14
	31.7550	100.00

They further state:

The schreibersite forms small tin-white crystals and grains, which cleave perfectly in one direction; the angular fragments are less irregularly formed and flatter than usual. Besides individual, lustrous, very fine spangles, which, according to their physical characteristics do not differ from the tænite of other meteorites, there occurs here very prominently a tænite of gray color, of inferior luster and greater thickness of folia, and of greater friability than usual.

The latter gave, from a solution in copper-ammonium chloride, the following analysis on 0.37197 gram:

C	Fe	Ni	Co	P	
1.18	73.85	23.88	2.12	trace	=101.03

which calculated to 100 for the tænite gives:

Fe	Ni	Co	C	
73.10	23.63	2.10	1.17	=100.00

An analysis of the angular fragments by Manteuffel is also given by Cohen,[8] which is as follows:

	Fe	Ni	Co	C	P	
I :	92.49	6.38	0.63	0.05	0.24	= 99.79
Ia :	93.27	6.04	0.64	0.05	....	=100.00

(I) Figures for a portion of the abundant isolated angular fragments.

(Ia) After deduction of 1.56 per cent schreibersite.

Copper=0.0258 per cent.

Meunier[9] described Staunton as follows:

The metal takes a very good polish, but nevertheless contains numerous small black inclusions.

No pyrrhotine is visible and the graphite is very inconsiderable. Schreibersite is not wanting. The figures are beautiful and a trifle peculiar. The kamacite bands are of quite uniform thickness but of very variable size. The tænite is very thin and continuous, forming a network in the plessite which is not very abundant but perfectly characteristic.

In his 1895 catalogue Brezina[10] expressed the belief that the fourth mass should be regarded a different fall from the others, his reasons being stated as follows:

Staunton I, II, III, V, the first two found in 1869, I–III described in 1871, and V described in 1887, agree very well together and show short, straight, and much swollen lamellæ, without hatching. The tænite is normal to very abundant; fields numerous but small, and filled with dark plessite or comblike ridges, or more frequently with schreibersitic or half-blended central skeletons, the former almost exclusively confined to the smallest areas, while the latter belong to the larger areas. Occasionally grains of cohenite occur in the kamacite, the latter being mostly granular and finely hatched.

Staunton IV, found 1858, described 1878, must be distinguished from the other masses—I, II, III, V—since from their structure they are evidently from another fall than this one. Staunton IV is a mass of 69 kg. weight, whose etching figures show long, straight, and somewhat hatched but not swollen lamellæ. The tænite is well developed, and the fields almost exclusively filled with combs resembling kamacite, or very rarely with dark plessite. The Reichenbach lamellæ are very numerous in the swathing kamacite. Troilite nodules of from 3 to 5 cm. diameter occur. The kamacite is granular and strewed with crystals of rhabdite. The chemical investigation of Weinschenk distinguished two sorts of tænite, the one flexible, the other brittle. Staunton IV is, moreover, from an unknown locality, while the four other masses of this name were found in the immediate neighborhood of Staunton, 1 to 5 miles distant, whither they were brought for sale by a negro.

Cohen[11] found that Staunton took on more or less permanent magnetism. He also determined the specific gravity of a piece weighing 160 grams to be 7.8279.

Ramsay[12] in 1896 reported an examination of the Staunton iron for argon and helium, with the following result:

I have examined the gas which is inclosed in meteoric iron (Staunton, Virginia, specimen). * * * We have obtained 45 c. c. of a gas some per cents of which disappeared on detonation with oxygen. The residue being submitted to electric sparks in presence of caustic soda underwent a slight contraction. The residue was dried with caustic soda, and I found by means of the spectroscope that it consists of argon, of which it shows all the characteristic marks.

We also observed the yellow line of helium, and on comparing it with a sample of pure helium, the identity was certain. It does not coincide with the D lines of sodium.

It is interesting to find the presence of argon in a substance foreign to the earth, though it has not been recognized in the sun.

It must be remarked in conclusion that there are no lines except those of argon and helium.

Campbell and Howe[13] reported a new mass in 1903, as follows:

In the list of accessions to the mineral collection of Washington and Lee University during the session of 1870–71 occurs the following note: "From Wm. N. Wilson, Esq., Augusta County, Virginia, a fine specimen of meteoric iron." There is no doubt but that the above entry refers to the meteorite now under consideration, inasmuch as it is the only one in the university collection which has no label, and there is no meteorite with the foregoing label. Since 1880 the history of this meteorite is definitely known. From 1886 to 1894 the meteorite was in charge of Prof. W. G. Brown. A fragment was cut from one end by him for analysis, the surface etched and photographed, but Professor Brown's analysis has not been published.

The question has naturally arisen as to whether this meteorite is from the same fall as the so-called Staunton meteorite which has been several times analyzed and in which Sir William Ramsay found the presence of helium. The meteorite was sent to Prof. Henry A. Ward, to be again cut, and an analysis of it was made for him by Mr. J. E. Whitfield. A fragment was also sent to Dr. Ramsay and examined by him for gases.

The analysis by Whitfield is as follows:

		Calculated to 100.
Fe	89.850	91.376
Ni	7.560	7.689
Co	.600	.610
Cu	.065	.066
P	.158	.161
S	.006	.006
C	.046	.047
Si	.045	.045
Oxide	1.560	.....
	99.890	100.00

Regarding the gases in the meteorite we are permitted to quote the following from Dr. Ramsay:

"The gases were extracted by heating *in vacuo*. This gas is very curious. There were only 3.52 cc.; none of it dissolved in KOH, Aq. On mixing with oxygen and sparking, there was contraction, and afterwards a large absorption of CO_2 with potash. The residue was very minute, so small indeed that on letting it into a small exhausted tube it was at a phosphorescent stage. But with a jar and spark-gap it was possible to see the argon blues, and without the jar the argon reds were just visible. I think I saw the helium yellow, but it was very feeble. The complete analysis is as follows:

Volume of gas from 6.54 grams of the meteorite....	3.52 cc.		
KOH. No contraction.			
Oxygen added.....	9.18		
	12.70		
After sparking.....	12.00		
Contraction for H_2O.....	0.7	$\times\frac{2}{3}$	0.46 H_2
Absorption with KOH.....	8.83		
CO_2 formed.....	3.17		3.17 CH_4
Add.....	0.46		
	3.63		
Argon, etc., say.....	0.02		0.02 A, etc.
	3.65		3.65 A, etc.

"Conceivably there may have been a trace of ethane, or of some hydrocarbon richer in carbon, in which case the CO_2 would not have been equal to the CH_4, but greater in volume. This might account for the small discrepancy between the amount taken, 3.53 cc., and the total, 3.65."

The question as to whether this meteorite is a portion of the Staunton fall is not settled by the analysis. It differs somewhat from the specimens analyzed by Mallet in 1871, but on the other hand it resembles in most particulars that analyzed by Mallet in 1878. It should be noted that Brezina considers that this latter specimen is not from the same fall as those earlier analyzed. The analysis of the gases would seem to point toward the present meteorite being identical with the Staunton, though it does not decide the question. It is peculiar in containing chiefly methane, but, like the Staunton, contains argon. Staunton is the only meteorite reported in literature, so far as we have been able to find, as containing helium, and in this there was but a trace. In the case of the present meteorite the presence of helium seems probable but not certain.

As regards the etched surfaces, they do not resemble those of the Staunton. Mr. H. L. Preston has called our attention to the complete absence of the club-shaped kamacite blades, so prominent in Staunton. These are also lacking in one other mass of the Staunton, and it was chiefly from this consideration that Brezina held that one to be a distinct fall.

Mr. Wirt Tassin of the United States National Museum has had the kindness to compare the photograph of the etched surface with the section of the Staunton iron described by Mallet in 1871, and writes as follows: "It shows quite a difference in structure. The tænite plates in the museum specimen are smaller, averaging only half the size of those in the photograph. The specimen also shows numerous fine lines of schreibersite, often regularly arranged especially in the plessite, and are occasionally so abundant as to give it (the plessite) a stippled appearance. These are lacking in the photograph, although this may be due to a difference in illumination. Finally, as you have already remarked, there is the complete absence of the bulb- or club-like kamacite blades."

We propose to call this meteorite Staunton No. 7. The original weight of the meteorite was somewhat more than 7 kgs.; its weight prior to the recent cutting was 7.15 kgs., its present weight is 6.04 kgs.

It is not clear why these authors call this the seventh mass as only five had been previously reported.

Staunton has been considerably distributed. Vienna has 6,001 grams; Budapest, 6,785 grams; and Harvard, 4,595 grams.

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Stewart County. See Lumpkin.

Stutsman County. See Jamestown.

Southeastern Missouri. See St. Francois County.

SUMMIT.

Blount County, Alabama.
Latitude 34° 15′ N., longitude 86° 25′ W.
Iron. Brecciated hexahedrite (Hk) of Cohen.
Described, 1890.
Weight, 1 kg. (2 lbs.).

This meteorite was first described by Kunz[1] as follows:

This mass of iron was found near Summit, Blount County, Alabama, latitude 33° 41′ north, longitude 86° 25′ west of Greenwich, by a 6-year-old negro girl who used it to crack hickory nuts. Its weight excited some curiosity, and her brother sent it to Mr. St. John of Summit, from whom it came into the possession of the writer. The mass measured 12.5 by 7.5 cm. (5 by 2 by 3 inches) and weighed one kilogram.

This meteorite contains a large quantity of free chloride of iron (lawrenceite) which formed in beads on the surface. The mass showed only a slight trace of the original crust and was almost completely oxidized. Etching produced no Widmannstätten figures but instead fine markings similar to that of the Linnville Mountain, North Carolina, meteorite.

Analysis by F. P. Venable:

Fe	Ni	Co	P	
93.39	5.52	0.58	0.31	=99.90

Specific gravity, 6.949.

Kunz gives also a cut showing the appearance of the mass as regards shape and one of an etched surface.

Brezina describes the meteorite as follows:

Shows a very peculiar structure which comes to view very distinctly on a transverse section through the entire mass. The one half of the plate is composed of oblong grains 1 to 5 cm. in size, which are partly separated by magnetically-altered schreibersite and partly shows Neumann lines, occasionally also troilite lamellæ inclosed in schreibersite; the other half of the plate is an individual which, toward the center of the plate, shows several lamellæ 1 to 2 cm. in size, partly compacted together, partly composed of small plates arranged together, which appear to be composed of troilite and schreibersite. The outer portion of this individual is partially filled with hieroglyphic forms of troilite and partially with crumpled vermiform deposits of troilite, such as occur only, so far as observed, in the Sao Juliao meteorite.

Cohen[4] remarks that the latter are schreibersite so far as can be determined without isolation and chemical investigation.

Brezina classified the iron as a brecciated hexahedrite,[6] a classification which Cohen[4] changed to granular hexahedrite (Hk). He remarked that the size of the grains is very variable.

The iron is somewhat distributed, the Vienna collection possessing 374 grams.

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Sumner County. See Drake Creek.

SURPRISE SPRINGS.

Near Bagdad, San Bernardino County, California.
Latitude 34° 33′ N., longitude 115° 48′ W.
Iron. Medium octahedrite (Om), of Brezina.
Found 1899.
Weight, 1,524 grams (3 lbs.).

This meteorite was first mentioned by Rust[1] but was described only by Cohen,[2] as follows:

According to Professor Ward, this iron was found in the summer of 1899, by D. J. Hayes, lying free on the surface of a quartz outcrop at Surprise Springs, on the south slope of the Bullion Range, about 45 km. southerly from Bagdad (San Bernardino County), in southern California. The assayer, J. Reed, in San Bernardino, cut for testing a flat piece from the end and determined that upon etching it produced beautiful Widmannstätten figures.

For closer investigation, I obtained a flat end piece of 157 grams weight, with a section surface of 33 sq. cm. (apparently the piece cut off by Reed), as well as a plaster model of the whole meteorite.

According to the model, the meteorite had the form of an abruptly truncated, slightly self-renewing cone, whose base and apex were arched like a condyle. Peripherally, there are two concavities nearly the full height of the mass, one of which is smooth and of a shallow shell shape, the other more deeply concaved and having an irregularly pitted surface. It seems that two chips were pried off here, but at a time when the meteorite still had a powerful momentum, since according to the model a complete incrustation took place. With the exception of the pitted surface of the large concavity the remaining exterior surface has only such small and shallow pittings that they do not show on the model or on a photograph. The characteristic finger-mark impressions and saucerlike pittings are entirely wanting.

The thin black crust covering one side of the section is apparently the original fusion crust, which, however, can not be entirely fresh, since it makes a reddish-brown streak, not a black one like the unchanged crust. Where it is entirely or even only in part rubbed away, the structure composed of octahedral lamellæ is plainly discernible. From the state of preservation of the exterior the fall may have taken place not long before the finding of the meteorite, unless, indeed, in the region in question, like that of West Atacama, atmospheric precipitation is almost entirely wanting, and a meteoric iron could keep almost unchanged for a long time.

Immediately upon weak etching, a zone of alteration becomes distinctly visible, which is from 2.5 to 7 mm. broad upon the surface of a section. In reality the breadth may be nevertheless fairly uniform and, indeed, 2 to 3 mm. Since the section under consideration is taken from a very slightly arched portion of the meteorite, and the exterior was accordingly cut through at both ends at a very acute angle, the zone shows very much broader here than its actual thickness warrants. On one side, where the zone becomes very small a thin chip has apparently been forced off, but at a time when the heat was sufficiently great to cause an alteration of structure, even though only to a slight depth. That the effect of the heat is confined to a comparatively small peripheral zone, may be explained by the fact that the meteorite upon entering our atmosphere possessed a comparatively low temperature and suffered a high degree of fusion only upon the exterior, and in consequence of its short duration, despite its intensity and the good conductor furnished by the nickel iron, could not spread to the interior. The existence of a zone of alteration also confirms the conclusion drawn from the condition of the surface, that no material change of form took place after the fall of the meteorite.

The kamacite is very rich in closely compacted etching lines and pittings, so that the etched surface, in consequence of the great diffusion of the reflection, appears dull, as is usually the case; yet the oriented luster is still quite distinct. The nongranular bands are in part long and then mostly notched, in part short and swollen. Tænite is well developed. Of the numerous fields, the larger are densely filled with combs. A few small ones are fine grained and very dark, as is usually the case.

Although the zone of alteration is distinctly divided from the inner portion of the meteorite, the structural alterations are comparatively small. The kamacite and the plessite show no intermingling, and accordingly the bands are still well defined. But the latter show neither etching lines nor etching pittings, but upon weak etching appear closely filled with small dark grains, and accordingly have a darker luster, from dull to weak in tone. After stronger etching the kamacite becomes still darker and finally breaks up into fine granules.

Of accessory constituents, there is only a moderate amount of schreibersite to be mentioned. It appears sometimes as small grains which lie in the bands, and sometimes as plates 2 cm. long by 1 mm. thick.

Surprise Springs lies on the boundary between medium and broad octahedrites, but may be reckoned with the former. From the fact that a few lamellæ of swollen form and irregular outline are found in the section surface, the texture as a whole makes the impression of a coarse structure.

Analysis:

Fe	Ni	Co	Cu	Cr	S	P	C	Cl	
91.01	7.65	0.89	0.07	0.04	0.08	0.22	0.02	0.02	=100.00

Mineralogical composition:

Nickel iron	98.33
Nickel-iron phosphide	1.43
Troilite	0.10
Daubréelite	0.10
Lawrencite	0.04
	100.00

The percentages indicate an abundant development of tænite. The comparatively high percentage of copper is noteworthy, which, however, was always free from iron, since it was doubly precipitated. The chromium is referred to daubréelite, although the correctness of this assumption is questionable, since from the analysis not sufficient sulphur was obtained to compute the total chromium from the daubréelite.

Specific gravity (Leick), 7.7308; for the nickel iron, 7.7570.

The meteorite is chiefly (1,410 grams) preserved in the Ward-Coonley Collection.

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Taney County. See Mincy.

TAZEWELL.

Claiborne County, Tennessee.
Here also Knoxville.
Latitude 36° 26′ N., longitude 83° 34′ W.
Iron. Finest octahedrite (Off), of Brezina; Tazewellite (type 13), of Meunier.
Found 1853; described 1854.
Weight, 27 kgs. (60 lbs.).

The first mention of this meteorite was by Smith,[1] as follows:

The meteoric iron was found in east Tennessee a short while ago, and weighed originally over 60 pounds. It is a highly interesting one, and has furnished for the first time the solid protochlorid of iron found in a fissure. It is also rich in the phosphuret of iron and nickel, and furnishes material for a full investigation of this latter mineral. The examination is nearly complete, and when finished a full history of the meteorite will be given.

Shepard [2] shortly after gave an account of the meteorite as follows:

For the specimens of the highly interesting mass here described I am indebted to Prof. J. B. Mitchell, of the East Tennessee University at Knoxville. Though but a fragment of three and fifteen-sixteenths pounds (having been detached from a mass originally weighing 60 pounds), it nevertheless has much the appearance of an independent meteorite. Its shape is that of an elongated three-sided pyramid whose axis is slightly oblique and whose upper edges are obscurely truncated so as to resemble an imperfectly formed six-sided pyramid of corundum. The height of the mass is 4 inches. The base is triangular and nearly smooth, presenting, however, a cleavage surface partially coated by brown oxide of iron. By this face it was originally connected with the larger mass of which it doubtless formed one of the sharpest extremities. It is certainly very remarkable that the cleavage should have been effected without leaving any hackly projections, the more so as the mass itself by no means yields to a similar cleavage in any direction whatever. Possibly the cleavage was occasioned by the interposition of a seam of pyrites in the direction in which it took place. At any rate its occurrence shows that these lumps, though generally composed of very tough and strongly coherent materials, are nevertheless susceptible of cleavage in certain directions, and that they may occasionally explode or subdivide into numerous fragments without the necessity of any very considerable force.

The upper planes of the pyramid are indented and somewhat undulating as is usual in meteoric irons, but there is no thick incrustation of peroxide; on the contrary it merely possesses for a coating a thin brownish-black pellicle which is much covered also by firmly adhering clay.

The iron is highly crystalline in its texture, a fact which may be seen in a few spots upon the surface even through the coating itself. It is exceedingly tough, breaking with the greatest difficulty and having a hackly surface in which no crystallization is apparent. The fresh surface is much whiter than pure iron and it retains its color and luster apparently without change from ordinary exposure to the air. Its specific gravity is 7.30.

A part of the broad cleavage surface (or base of the pyramid) above described was polished and acted upon by dilute hydrochloric acid. The corrosion was very partial but it revealed a perfectly crystalline structure in the iron. The subsequent application of nitric acid rendered it still more striking. The Widmannstättian figures are somewhat peculiar. While there is a general ground subdivided by innumerable thin and perfectly straight lines into small equilateral triangles and oblique-angled parallelograms of similar areas in size, presenting a picture on the whole closely resembling the Guildford (North Carolina) iron, there are also irregularly disposed veins or interrupted seams of a shining white metal one-twentieth of an inch in thickness and each from one-half to three-quarters of an inch long. These occur on the whole pretty near together and impart a singular aspect to the surface, inasmuch as the veins do not coincide in direction with the fine lines above mentioned, nor do they follow any parallelism with one another.

Neither of the acids employed attack this substance in the slightest degree any more than they do the thin lines producing the small and regular areas. But closely associated with the larger veins are noticeable small particles of magnetic pyrites which, as usual, are decomposed by the acid.

Having separated a few grains of this metal or ore forming the seams and heated it with acids I convinced myself that it is identical with the substance which I discovered as entering into the composition of the Seneca Falls (New York) meteoric iron and which I denominated Partschite.

A fragment of the iron was treated with hydrochloric acid. The solution went on very slowly and unattended by the extrication of any sulphuretted hydrogen. The solution proceeded so slowly that it required nearly three days to dissolve 26.5 grs. of the iron, although the process of digestion was several times hastened by the application of a gentle heat. The acid left behind 1.16 grs. of undissolved matter in the form of innumerable brilliant crystalline scales of an iron-gray color and a high metallic luster. When washed and dried they were found to be flexible, highly magnetic, and insoluble by hydrochloric acid, but were readily attacked by hot nitric acid, though still leaving undissolved a few particles of another metallic species, supposed to be the Partschite, and which were finally taken up by digestion in warm aqua regia. The thin crystalline scales undoubtedly consist of the schreibersite (of Patera).

From the hydrochloric solution a precipitate was obtained (by means of a stream of sulphuretted hydrogen) which, after washing and reduction before the blowpipe, yielded metallic copper. A solution of the perchlorid was precipitated by ammonia and the peroxyd of iron thus obtained was ignited with nitrate of potassa, when its solution gave decisive evidence of the presence of chromic acid.

The proportion of nickel obtained from the iron (without including the schreibersite and partschite) was 12.10 to 13.05 per cent, thus placing the present meteorite, as regards the high proportion of nickel, in the rank of the following rather small number of meteoric irons, viz, that of Caille, which has 17.37; of Claiborne, Alabama, which has 12.66; of Greene County, Tennessee, 14.7; of Krasnojarsk, 10.7; of Bitburg, 11.9; and of Cape Colony, Africa, 12.27.

I have abstained from a complete analysis of the present iron, as Prof. J. Lawrence Smith is, as I understand, about to publish full results of this nature.

The following is an abstract from Professor Mitchell's letter in reference to its discovery: "This meteorite was found April, 1853, about 10 miles west of Tazewell, Claiborne County, Tennessee. It was discovered by a son of William Rogers while plowing in clayey ground on the side of a hill where the soil had been much washed away by rains. His attention was arrested by the resistance and noise produced when the mass was struck by the plow. The lump weighed about 60 pounds. It was very irregular in its shape. The period of its fall is of course unknown. On account of its weight and luster it was regarded as silver and it was with no small difficulty that the finder was induced to part with it, even by my paying him what appeared to be an equivalent and then agreeing to give him its weight in silver provided it should prove to be that metal when properly examined. For my first information of the iron I am indebted to J. C. Ramsay, Esq., a gentleman who, not limiting his researches to the mere details of his profession, loses no opportunity of contributing to several branches of natural history. I retain a fragment of about 6 ounces which he first gave me for examination. The remainder of a mass was broken when I saw it into two pieces, one of which, weighing perhaps 3½ pounds, I send to you. The largest portion I transferred as I informed you to an acquaintance for examining and reporting upon the same. These three embrace all the pieces into which this meteorite has been divided."

Smith's [3] later description was as follows:

This meteorite was placed in my possession through the kindness of Prof. J. B. Mitchell, of Knoxville, in the month of August, 1853. It was found by a son of Mr. Rogers, living in that neighborhood, while engaged in plowing a hillside; his attention was drawn to it by its sonorous character. As it very often happens among the less informed, it was supposed to be silver, or to contain a large portion of that metal. With some difficulty the mass was procured by Professor Mitchell and passed over to me. Nothing could be ascertained as to the time of its fall. It is stated among the people living near where the meteorite was found that a light had been often seen to emanate from and rest upon the hill—a belief that may have had its foundation in the observed fall of this body.

The weight of this meteorite was 55 pounds. It is of a flattened shape with numerous conchoidal indentations and three annular openings passing through the thickness of the mass near the outer edge. Two or three places on the surface are flattened, as if other portions were attached at one time but had been rusted off by a process of oxidation that has made several fissures in the mass so as to allow portions to be detached by the hammer, although when the metal is sound the smallest fragment could not be thus detached, it being both hard and tough. Its dimensions are such that it will just lie in a box 13 inches long, 11 inches broad, and 5½ inches deep. The accompanying figure gives a correct idea of the appearance of this meteorite.

The exterior is covered with oxide of iron in some places so thin as hardly to conceal the iron, in other places a quarter of an inch deep. Its hardness is so great that it is almost impossible to detach portions by means of a saw. Its color is white, owing to the large amount of nickel present, and a polished surface, when acted on by hot nitric acid, displays in a most beautifully regular manner the Widmannstättian figures. The specific gravity, taken on three fragments selected for their compactness and purity, is from 7.88 to 7.91.

The following minerals have been found to constitute this meteorite: 1. Nickeliferous iron, forming nearly the entire mass. 2. Protosulphuret of iron, found in no inconsiderable quantity on several parts of the exterior of the mass. 3. Schreibersite, found more or less mixed with the pyrites and in the crevices of the iron, in pieces from the thickness of the blade of a penknife to that of the minutest patricles. 4. Olivine; two or three very small pieces of this mineral have been found in the interior of the iron. 5. Protochloride of iron; this mineral has been found in this meteorite in the solid state, which I believe is the first observation of this fact; it was found in a crevice that had been opened by a sledge hammer, and in the same crevice schreibersite was found. Chloride of iron is also found deliquescing on the surface; some portions of the surface are entirely free from it, while others again are covered with an abundance of rust arising from its decomposition.

Besides the above minerals, two others were found—one a siliceous mineral, the other in minute rounded black particles; both, however, were in too small quantity for anything like a correct idea to be formed of their composition.

An account in detail of the component minerals is also given by Smith. His analysis of the meteorite as a whole is given under I, of the troilite under II, and of the schreibersite under III.

	Fe	Ni	Co	Cu	P	Cl	S	SiO_2	MgO	CaO	Total	Sp. gr.
I.....	82.70	14.82	0.46	0.07	0.18	0.02	0.08	0.65	0.24	....	99.22	7.89
II.....	62.38	0.32	....	trace	.....	....	35.67	0.56	....	0.08	99.01	4.75
III.....	56.53	28.02	0.28	.....	14.86	....	.....	....	....	....	99.69	7.017

Harris [4] was persuaded that the lawrencite was first formed after the fall. Reichenbach [7] called attention to the regularity of the Widmannstätten figures and the delicacy of the tænite threads; he also mentioned an "Ablösung" and a fragment of magnetic pyrites over an inch in size bordered with yellowish iron sulphide.

Rammelsberg [5] raised the question whether iron sulphide in iron meteorites was pure iron sulphide or magnetic pyrites, considering the results of Smith not decisive, although he himself, as it seems did not doubt that the former was present. Rose [6] observed thin strips of schreibersite, which followed only one system of straight bands and considered that Tazewell is distinguished thereby above all other meteoric iron. Wright [9] investigated the gases.

Meunier [8, 15] concluded at first, from the analysis by Smith, that Tazewell consisted only of tænite, later he stated that plessite was also present in considerable quantity. The mark designated by Smith to differentiate troilite from magnetic pyrites he regarded as insufficient. He noted the ready cleavage of the iron sulphide and the presence of graphite, bordered with schreibersite. When he stated that Smith had observed a regular crystal of iron chloride, he must have been mistaken.

Sorby [17] cited Tazewell as a distinguished example of fine and especially beautiful Widmannstätten figures; he considered it free or almost free from schreibersite and composed of two alloys of nickel iron, one of which was readily attacked by weak acid, the other, when first crystallized out, was not at all affected thereby. He compared the structure with the kind of ice which consists of a skeletonlike network and meshes filled out later. According to him, Tazewell belongs to irons with original structure in contrast with those formed by later crystallization (for example, Ruffs Mountain).

In 1880 Brezina [11] called attention to the relationship of Tazewell with Butler in structure, occasioned by the strong predominance of plessite and tænite, and left it doubtful whether the extremely thin core of the lamellæ is to be regarded as identical with the kamacite. He mentioned troilite and schreibersite plates as minor ingredients. In 1885 he [14] separated Tazewell, together with a few other irons as finest octahedrites from those with fine lamellæ, and characterized the same as a fine network of extremely fine lamellæ not grouped; tænite about the same in quantity as the plessite or the latter predominating to some extent; kamacite scarce, as in the case of Butler; bands from .05 to .1 mm. broad.

Cohen [23] described the meteorite as follows:

> Tazewell is poor in kamacite, not in consequence of the small number of bands, but because of their narrow width; nevertheless, by strong magnifying it is distinctly marked off from the surrounding well-developed tænite bands, which are prominent in the lamellæ. The fields predominate in a considerable degree and show varied formation. One portion consists of dense and very dark plessite; it is only by strong magnifying that one can discern a structure of fine granules with occasional inclusions of tiny glistening points; this plessite is very readily affected by acid and appears to be identical with the kamacite of the bands. Another portion of the fields appears bright by reason of strong reflection of the light, is hard to affect by acids, and is composed of an intimate mingling of dense kamacite and numerous small, uniformly distributed leaves of tænite. In many places both sorts of plessite are represented by very nearly equal areas of considerable extent; in other places one sort predominates, and thereby arises a characteristic change in the appearance of the etched surfaces. Occasionally there occur in the areas of the twofold sort comblike excrescences, which vary from the width of the principal lamellæ to microscopic fineness, and only very rarely fill entirely or nearly so a small field.

Dodecahedral lamellæ of nickel iron were described by Brezina and Cohen,[16] which originating from the octahedral structure, usually reached halfway into the fields and inclosed a center of schreibersite. According to Brezina's [22] more recent investigations it is the lamellæ

of the latter whose arrangement approaches the dodecahedral system so that their enveloping kamacite plays the rôle of swathing kamacite, and there are also present entire dodecahedrons of schreibersite.

Tazewell takes on strong permanent magnetism. The specific magnetism was determined by Leick as 2/73 absolute units per gram.[20] Farrington[21] found that Tazewell as well as all the meteoric irons tested by him, was active; but it usually took as much as 15 minutes before the deposition of copper occurred in Tazewell, while in the case of all other irons, even in those equally rich in nickel, the reaction became distinctly noticeable in 4 minutes at the latest.

The largest quantity of the meteorite (23 pounds) is in the Amherst collection. The Washington Shepard collection has 1,943 grams; Harvard 754 grams.

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TEOCALTICHE.

Canton Teocaltiche, State of Jalisco, Mexico.
Latitude 21° 25′ N., longitude 102° 27′ W.
Iron. Octahedrite (O) of Brezina.
Found 1903.
Undescribed.
Weight, 10 kgs. (22 lbs.).

The only mention of this meteorite seems to be by Ward,[1] who gives the above information and states that the original mass (weight 10 kilos) is in the Museum of the Instituto Geologico, City of Mexico.

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Teposcolula. See Yanhuitlan.

Texas, 1808. See Red River.

THURLOW.

Hastings County, Ontario, Canada.
Latitude 44° 22′ N., longitude 77° 20′ W.
Iron. Fine octahedrite (Of) of Brezina.
Found 1888 (Berwerth); 1895 (Ward).
Recorded 1897.
Weight, 5.42 kgs. (12 lbs.).

This meteorite was first mentioned [1] so far as the present writer is aware in a brief preliminary notice in the American Journal of Science as follows:

The mass was found by Mr. E. S. Leslie, jr., May 12, 1888, on about the center of the 28th lot of the 6th concession of the township of Thurlow, Hastings County, in the Province of Ontario. This meteoric iron, which would appear to have been brought to the surface by plowing, is described by Doctor Hoffmann as an irregularly shaped, truncated pyramidal mass, with a more or less rectangular base, measuring 16 by 13.5 or, including an elongated projection, 17 cm. in its diameters, and 10 cm. in height; its weight is 5.42 kgs. The entire surface is pitted and coated with a chestnut-brown, slightly glimmering film of oxide of iron.

Berwerth [2] mentions fine lamellation, likewise fine-netted plessite fields as characterizing the meteorite. He classified it as a medium octahedrite.

Cohen [3] groups the iron with the fine octahedrites and describes the structure as follows:

The bands are for the most part grouped and surrounded with distinctly visible tænite. The longer bands are regular in shape while the shorter are swollen both on the ends and in the direction of their length. The lamellæ in part lie close together and in part are separated by very small ($\frac{1}{10}$ to $\frac{1}{3}$ mm. in width) elongated fields which, like the other fields of narrower compass, consist of dark, compact plessite in which can be discerned on stronger magnification, as usual, angular shining flakes. In some fields of this sort may be seen, lying singly or isolated, complete lamellæ, or the central part of a field may be, through an increase in the number of the angular shining flakes, brighter than the narrow zone about it. The larger fields show, even as well as the lamellæ, a repetition of the coarser structure. Complete lamellæ 0.02 to 0.1 mm. in width, and either singly or in groups, lie in the central part of the fields closely pressed together so that only very small portions of the compact, dark plessite occur between them, although the latter rules the space toward the edge of the fields. This produces a well-marked edge which gives a characteristic appearance. The small lamellæ are not outgrowths of the chief lamellæ, at least as a rule, since they are generally swollen or acute wedge shaped, and often are plainly inclosed in a tænite shell. Evident outgrowths of the larger lamellæ, however, also occur. The kamacite appears coarse and cross-hatched both to the naked eye and under a lens. With a higher magnifying power, however, one sees, both in the large lamellæ and the small lamellæ of the fields, that it has a dark streaked structure which as a rule runs in one direction but also is much crossed. This occurs as black veins consisting of fine and coarse, irregularly bounded threads which have the appearance of resulting from the extrusion of carbon-rich iron. The kamacite, therefore, appears darker and duller than usual; it gives no oriented sheen and is noticeably different from that of other octahedrites. Among accessory constituents schreibersite is the most abundant. The smaller individuals of this mineral occur in the form of grains and prisms embedded in the bands and cause a swelling of the latter where they occur in quantity. The larger individuals are chiefly prismatic though irregular in shape and are surrounded by swathing kamacite of the same character as the kamacite of the lamellæ. I also observed, though but rarely, little grains of troilite surrounded by schreibersite lying in the swathing kamacite.

The following analysis made by Dr. O. Bürger is given by Cohen:[3] I being the complete analysis and Ia showing the composition of the nickel iron after deducting 0.14 per cent troilite and 1.62 per cent schreibersite.

	Fe	Ni	Co	Cu	Cr	P	S	
I	89.17	9.92	1.04	trace	trace	0.25	0.05	=100.43
Ia	89.37	9.62	1.01	trace	trace	....	....	=100

The meteorite is somewhat distributed but is chiefly in the possession of the Geological Survey of Canada at Ottawa.

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TLACOTEPEC.

District of Tecamachalco, State of Puebla, Mexico.
Latitude 18° 45′ N., longitude 97° 39′ W.
Iron. Octahedrite (O), of Brezina.
Found 1903.
Weight, 24 kgs. (53 lbs.).

The only mention of this meteorite seems to be by Ward,[1] who gives the above information and states that the mass (weighing 24 kgs.) is in the Museum of the Instituto Geologico, City of Mexico.

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TOLUCA.

Mexico.
Here also Ixtlahuaca, Tejupilco, Xiquipilco.
Latitude 19° 24′ N., longitude 99° 44′ W.
Iron. Medium octahedrite (Om), of Brezina; Caillite (type 18), of Meunier.
Known before 1776; mentioned 1784.
Weight: Several hundred masses, some weighing as much as 150 kgs. (300 lbs.) each.

The first printed mention of this meteorite seems to have been in the Gazetas de Mexico,[1] in 1784, as follows:

In the town of Xiquipilco, belonging to the district of Ixtlahuaca, native metallic iron is met with so pure that, without any other preparation than heating, it may be worked into any shape; as I have verified in two journeys undertaken with the object of discovering if there were any veins of this mineral which would be of infinite utility; but my observations only verified the fact that masses of various shapes and sizes are found scattered through the fields and that Indians keep a lookout for them, though the iron is at first covered with a crust of ocher. The Indians of the town and the owners of the haciendas use no other for the fabrication of the necessary agricultural implements.

Del Rio,[2] in 1804, gave as a Mexican locality for native iron: "Near Cuernavaca, in Xiquipilco."

Humboldt,[3] who had been in Mexico in 1803–4, says:

It is to Sonneschmid that we are indebted for a knowledge of the meteoric iron which is found at several places in Mexico, for example, at Zacatecas, Charcas, Durango, and, if I am not mistaken, in the vicinity of the small town of Toluca.

Chladni[4] repeated the account in the Gazetas de Mexico and mentioned a specimen of the Toluca iron in the Vienna collection.

Nöggerath[5] gave the following data in a letter to Chladni, under date of June 25, 1826:

I can now give you more exact indications concerning the place of discovery of the meteoric iron which I obtained on the occasion of your recent visit to Bonn, and from which I permitted you to saw a specimen. It is from a letter written by Mr. Wilhelm Stein, general agent for the German-American Mining Union, dated Mexico, April 23, 1825, and sent to the address of the aforesaid Union at Elberfeld. Mr. Stein says, concerning the subject in this letter:

"Among the minerals which I send you there is a piece of pure iron from Jiquipilco, 10 leagues northeast of Toluca. The occurrence of this iron deserves to be more closely investigated. As yet there is little or nothing known about it, and I was not permitted to clear up this uncertainty upon the occasion of my first trip to Jiquipilco, because I was not so fortunate, despite my painstaking search, as to find a piece of the questionable iron in its place of discovery. It is known, moreover, that a considerable quantity of this iron was found in plowing the ground in that vicinity, and that it was used to make all sorts of tools. The accompanying specimen was given me as a present by John Gould, a North American, who obtained it at the original locality."

These data, therefore, largely confirm those which you have already given concerning this locality in your great work on meteors (Wien, 1819), p. 338.

I have etched a polished surface from the thick and compact piece of this iron which you saw in my possession, and obtained quite distinct Widmannstätten figures. The bands intersect one another in two directions, and are somewhat irregularly rectangular. The design is more distinct, but most resembles that shown by the polished surface of the small specimen found in the Vienna natural history cabinet and figured by Schreiber in his Beiträgen (Wien, 1820), Plate VIII. Since the iron mass from Zacatecas does not entirely correspond to that of Jiquipilco, it may be supposed that the aforesaid small Vienna specimen, which came from the larger one in the Klaproth collection, also originated from Jiquipilco.

Since we met I have obtained a second piece of that iron, which was cut from the mass sent by Stein. It has the advantage of the former firm and compact piece, in that its structure is plainly visible without any etching. A flat exterior is, as it were, cleft in two directions which correspond to the structure. Upon this exterior a few large reentrant angles are present, which likewise indicates the structure. As can be readily seen on the etched surface of the first piece, the lines running in one direction are more distinct and less interrupted than those running in the other direction. In the direction of the first occur several parallel clefts, which are so loosened that it would require comparatively little force to separate the piece into several lamellæ. I have never seen a similar appearance in any other meteoric iron.

Berthier [6] described as follows a specimen obtained from Humboldt:

It was very pure, without scoria, but very ductile and tenacious; it may be bent and twisted several times in the same place before it will break. It contained 0.0862 per cent nickel, or about 1 atom of nickel to 12 of iron, but no trace of cobalt or chromium was obtained, nor of combined carbon.

Alzate Ramirez,[7] in 1831, reported concerning the meteorites as follows:

From time immemorial no iron has found its way to the town of Xiquipilco and to the neighboring haciendas for the necessary purposes. The Indians of Xiquipilco collect what they can, for it is not abundant; the owners of the haciendas of Indege and Santa Isabel barter for it with the Indians who chance to find it, generally at the beginning of the rains, when it becomes visible among the soil. The Indians of Xiquipilco make spades and axes of the iron, and the owners of the said haciendas use it for plows. About the year 1776, I went to Xiquipilco to see with my own eyes the famed native iron. I found two smiths established in the town who worked the native iron; and in my sight they forged it and worked it into the shape demanded of them.

Partsch [8] described the Vienna specimen as follows:

Native iron, compact without visible admixture of other minerals. In a small piece in the collection, which, besides one strongly etched surface, possesses only hammered faces, even troilite is lacking. Widmannstätten figures appear on etching with acids, at least on the piece in the collection. This shows striations according to two directions or occasionally three directions. The piece in the Vienna Museum is triangular and is from a mass weighing about a pound, which lay in a field and was used by the Indians for an axe. One strongly etched surface shows Widmannstätten figures, while the natural surface has a granular character.

In 1853 Nöggerath [9] gave the following brief note regarding the etching figures (see also page 499, under Zacatecas):

Widmannstätten figures were produced upon this meteorite by etching, and the specimen also showed surfaces upon which these figures stood out in relief, as is customary in the case of steel. The iron showed, in the Widmannstätten figures, the peculiar structure of meteoric iron very distinctly. The design was finer in the case of Toluca than in that of Zacatecas.

In 1854 Uricoechea [10] made the following analysis of Toluca iron:

According to Partsch this iron has been known since 1784 and came from Xiquipilco, north of Toluca, in Mexico. Several years ago a large piece was brought to Europe by Stein of Darmstadt. Professor Wöhler obtained several fragments of this piece from Liebig weighing together about 10.5 ounces. It is distinguished by the fine figures produced thereon by etching which show all the peculiarities which Partsch, for example, described in the case of the Elbogen iron. Upon the somewhat oxidized surface it has, like the iron from Arva, tolerably large scales of schreibersite of a yellowish-white color and metallic luster; there are also isolated particles of grayish-yellow iron sulphide cropping out here and there.

As there is but one analysis of this iron extant, and as this is evidently incomplete, namely, that of Berthier, which only determined the iron and nickel contents, at the instigation of Professor Wöhler, I made a new analysis of it and used for the purpose the filings which were produced by the cutting of the above-mentioned pieces. These were treated with ether in order to remove the oil which was used in sawing. I do not consider it necessary to describe the method of analysis since it was the same as used by Prof. Wöhler in his analysis of Rasgata.

For the analysis 5.1334 grams were employed. The hydrogen developed by dissolving in HCl smelled like hydrogen sulphide and gave a slight precipitate in a lead solution. After complete decomposition by the acid, washing and drying, there remained .211 gram or 4.11 per cent of a black, insoluble residue.

Under a magnification of 80 diameters, this residue showed an appearance like that obtained by Wöhler from the iron of Rasgata. It consisted (1) of metallic, crystalline particles which were attracted by the magnet. These were nickel-iron phosphide. They formed the principal quantity of the residue. (2) Grains of a milk-white color. (3) Colorless, vitreous grains. (4) Brownish-yellow, olivinelike grains. (5) A single grain of a ruby-red mineral such as had also been observed by Wöhler in this iron in an incomplete analysis, and finally (6) a sky-blue, transparent mineral which seemed to be crystallized and resembled the zircon from Vesuvius. A similar blue mineral was found in Rasgata by Wöhler and referred by him to sapphire. By treatment with aqua regia, the 4.11 per cent of residue was divided into 2.99 per cent of nickel-iron phosphide and 1.11 per cent insoluble mineral, the colorless grains of which may have been in part introduced sand grains.

By saturating the hydrochloric acid solution with hydrogen sulphide, a small yellow precipitate was obtained which appeared to be copper and tin.

In 100 parts of the whole iron the following were found:

Fe	90.40
Ni	5.02
Co	0.04
X (equals schreibersite)	2.99
P	0.16
Y (minerals)	1.11
Z (Cu, Sn, Mn, S)	trace
	99.72

Pugh [11] reported an analysis as follows:

Stein of Darmstadt obtained 4 masses of this iron, which weighed respectively 5.5 pounds, 13 pounds, 19.5 pounds, and 220 pounds. The analysis of the 13-pound mass was made by Uricoechea (see above). Those of the 19.5 and 220 pound masses were made by me.

I. The 220-pound mass.

It is covered with a tolerably thick coating of rust, in which are found many yellowish scales of schreibersite with metallic luster. Many yellow drops of iron chloride are also found upon it, such as may be observed on many other meteorites. These drops of iron chloride do not appear upon the polished section.

This iron had a coarsely foliated, crystalline fracture and after etching it shows very beautiful Widmannstätten figures very similar to those of the Elbogen iron. It is not passive. By dissolving in diluted muriatic acid hydrogen sulphide is emitted, an evidence that it contains pure iron sulphide. Several tests left 0.9 and 1.24 per cent of a black insoluble residue, consisting of schreibersite, graphite, and microscopical grains of a yellowish and a colorless mineral. Two analyses of this iron gave:

	I	II
Fe	90.43	90.08
Ni	7.62	7.10
Co	0.72	.....
X (equals schreibersite)	0.56	.....
P	0.15	.....
CuSn	0.03	.....
S	0.03	.....
Y (graphite and insoluble minerals)	0.34	.....
Insoluble	.....	1.24
	99.88	98.42

II. The 19.5-pound mass.

The exterior is much less oxidized than the larger mass, which may be due to the circumstance that the latter lay in a dry river bed. Scales of schreibersite and an exudate of yellow drops of iron chloride were also noted. What makes this meteoric iron especially noteworthy, however, is that it contains here and there, even in the middle of its mass, small particles of greenish, granular olivine. It is unusually hard, much harder than the larger mass, so that it is very hard to cut and quickly dulls the cutting tools. It has a coarsely foliated crystalline fracture. It yields very complete figures upon etching. It is not passive. It develops no hydrogen sulphide gas in the process of dissolving in muriatic acid. Tests from different parts left 0.568 per cent and 1.58 per cent of insoluble black residue, which consisted of schreibersite, graphite, and transparent grains of a colorless, a ruby red, and a greenish mineral.

Three analyses of this iron gave the following results:

	I	II	III
Fe	87.894	88.280	87.880
Ni	9.056	8.896	8.860
Co	1.070	1.040	0.893
P	0.620	0.784	0.857
X (equals schreibersite)	0.341	.....	.....
Mn	0.201	.....	.....
CuSn	traces	.....	.....
Y (graphite and minerals)	0.224	.....	1.236
	99.406	99.000	99.726

It is evident that this iron is distinguished by an unusually high percentage of phosphorus and cobalt, which may account for its extreme hardness.

Taylor [12] made an examination and analysis of the iron with the following results:

The meteoric iron from Xiquipilco, Mexico, appears to have been first mentioned in the Gazeta de Mexico in 1784. It is stated there that small pieces of native iron, from a few ounces to 50 pounds in weight were very numerous, which were sought for by the Indians after heavy rains, who used them for manufacturing agricultural implements.

In the examination made by M. Berthier he failed to detect the presence of cobalt, but it is mentioned by Professor Clark that Manross had found it in a specimen from the cabinet of Professor Wöhler; my examination confirms that of Mr. Manross.

To the kindness of W. S. Vaux, Esq., I am indebted for the material for this investigation; Mr. Vaux has in his magnificent cabinet the principal portion of a mass which weighed over 10 pounds. It was originally about 6 inches long, with an average diameter of 3 inches; the lump was oblong with rounded ends, the whole being covered with a thin crust of limonite.

A cross section cut from this lump has been carefully polished and etched by strong nitric acid, which gives a most beautiful surface of about 3.5 inches in length by 2.5 in breadth, covered with the greatest complexity of Widmannstätten figures which almost defy description.

The surface is crossed by bands about one-tenth to one-sixteenth of an inch in breadth; these apparent bands are cross sections of different planes, as is readily perceived by their different refractive powers.

On changing the position of the specimen, those that are a bright silvery white in one direction become a dull gray in another, and vice versa.

There are several systems of bands which preserve a parallelism among themselves and cross other systems at various angles, forming trapezoids, rhombs, and triangles. These several fields and their characteristic etchings will be described in detail at some future time. Along the bands or planes thin laminæ of schreibersite have been observed, as in other meteoric irons.

Embedded in one side of the large lump (just described) was a globule of pyrrhotine which looks as if it had been dropped into the iron when it was in a semifluid state. This globule appears to have been about an inch in diameter; it was in part decomposed, but a small portion of the mineral was separated sufficiently pure for the determination of its specific gravity and analysis. On dissolving it in hydrochloric acid thin laminæ of schreibersite separated with minute portions of chromic iron.

Through the kindness of Dr. F. A. Genth I have been permitted to make the following analysis in his laboratory:

No. 1. Pyrrhotine dissolved in nitric acid gave—

Sulphur	33.76
Iron	57.95
Nickel	6.70
Cobalt	.56
Silicon	.05
Phosphorus	.25
	99.27

No. 2 dissolved in hydrochloric acid gave—

Iron	58.25 per cent.

A residue remained which dissolved after being treated with hydrochloric acid and chlorate of potash consisted of—

Copper	0.12 per cent.

The remainder consisted principally of chromic iron with a small portion of schreibersite.

The specific gravity was found to be 4.822.

The ratio of sulphur to the metals was found to be—

Sulphur	2.102	Iron	2.066	2.301
		Nickel and cobalt	0.245	

It will be seen that the composition corresponds with that of pyrrhotine, considering its formula to be FeS, if we disregard the few impurities which were found with it.

The meteoric iron was first treated in a flask with hydrochloric acid and the gas evolved was passed through a solution of ammonia chloride of copper, but not a trace of sulphur could be detected in this manner.

In the fifth supplement to Rammelsberg's Handwörterbuch der chemischen Mineralogie, this meteoric iron is mentioned as passive, experiments having been made by Professor Wöhler; but the piece belonging to Mr. Vaux is evidently active, throwing down metallic copper from a neutral solution of its sulphate. This experiment was repeated with great care with confirmatory results.

No. 1 was dissolved in hydrochloric acid, and a slight precipitate was obtained by hydrosulphuric acid, which, on a careful examination before the blowpipe, was found to be copper with a trace of tin.

Iron	90.72
Nickel	8.49
Cobalt	.44
Schreibersite, chromic iron, etc	.38
Silicon	.25
Phosphorus	.18
	100.46

The phosphorus was estimated in a separate portion which was first oxidized by nitric acid and fused in a platinum crucible with carbonate of soda.

No. 2 was dissolved in nitric acid. It gave:

Iron	90. 37
Nickel	7. 79
Insoluble residue	1. 91
	100. 07

Jordan [13] gave the following analysis:

The piece of meteoric iron from Jiquipilco, Mexico, obtained from my friend, G. A. Stein, forms a complete individual, whose form is somewhat comparable to that of a pear, if one views it lengthwise, compressed on three sides at the thicker end and on two sides at the thinner end, somewhat bulged, the edges sometimes rounded and sometimes sharp, and having finger prints, the deepest and longest of which are upon the under thicker end. If one proceeds from the idea of an original easily altered general condition of the mass, he will be led to the type of the drop form, while the irregularities of the surface may be referred to outside influences upon the still incompletely hardened bodies.

The weight was 5.5 pounds; the length, 17 cm.; the greatest width, 8 cm.; the greatest thickness, 7 cm.

The exterior portion of the mass consisted of an oxidized crust, like that of compact limonite, in part also like that of limonite ocher, upon which golden drops of an iron sulphide solution appear here and there. A surface 4 by 2.5 cm. in size in the middle of the mass was covered with a thin film of fresh iron rust on portions of the crust, amidst which file marks were to be seen. On these parts none of the before-mentioned drops were visible.

For grinding the above-mentioned parts, which had already been attacked with the file, were utilized. There the oxidized crust appeared to be of very uneven thickness, from that of a single card to several millimeters. The Widmannstätten figures revealed themselves merely by polishing the surface and came out in all their beauty after etching. They form, for the most part, larger and smaller parallelograms, sometimes rectangular, sometimes oblique, and inclosed by small and not entirely straight threads of schreibersite, between which (parallelograms) trapeziums, trapezoids, and triangles are interspersed. The form and grouping of the figures are exactly similar to those on a polished and partially etched, partially blued surface of the piece formerly belonging to Stein, the original 13-pound mass which Doctor Uricoechea analyzed. In many threads of schreibersite on both pieces and especially upon the blued surfaces, two plates closely twined together can be clearly distinguished. A look at these figures, here as in other meteoric irons, led to the idea of the origination of this mass from an aggregate of individual, originally separated crystalline bodies, which in a still glowing condition were welded together by force of attraction.

This iron is not passive, as proved by tests with copper sulphate. In the crust no other minerals were to be found, no olivine and no schreibersite.

For the analysis of this meteoric iron, which was made by Doctor Nason in Wöhler's laboratory, filings from the thin sections were contributed by Dr. Jordan. Five grams weight of this was dissolved in dilute muriatic acid. The hydrogen gas evolved had only a very slight smell of hydrogen sulphide. The black, insoluble residue comprised 0.216 per cent. It was composed, as usually, of schreibersite. In general the following constituents were found:

Fe	90. 133
NiCo	7. 241
P	0. 376
Insoluble residue	0. 216
Iron sulphide	Trace.
Loss	2. 034
	100. 000

The loss consisted at least for the most part of oxygen, and was due to the fact that the filings were somewhat rusted. In the analysis this iron agreed very closely with that of the 220-pound mass from Jiquipilco, analyzed by Doctor Pugh, and now in the possession of Stein.

Burkart [14] gave the following account:

This meteoric iron (Toluca) is not found in one large mass or in a few heavy pieces, but is distributed in many small masses in the neighborhood of the Indian village of Xiquipilco. This town lies on the plateau of the Cordilleras of Mexico, scarcely two days' journey from the principal city of the land, in the valley of Toluca, on the upper part of the Lerma River, or, as it is called farther down toward its mouth on the South Sea, the Santiago River, almost 3 miles from the river, between two of the higher mountains of Mexico, more than 12,000 to 14,000 feet above the sea, namely, the extinct old volcano of Cerro de Hocotitlan and Nevada de Toluca, in the jurisdiction of Istlahuaca, 3 miles from the latter place and 6 miles north-northeast from the city of Toluca, upon the first elevation which bounds the valley on the west. The locality as given by Boguslowski—Toluca, near Xiquipilco—is accordingly incorrect. The Gazeta de Mexico, Del Rio, Chladni, Schreibers, Nöggerath, and Partsch indicated the locality correctly and have already made known the meteoric iron under the name of Xiquipilco throughout a wide circle. In recent times numerous travelers have brought fragments of it to Europe.

The earlier accounts state that the Xiquipilco iron was found in isolated masses of varying size and weight in the neighborhood of the village above named, and was sought there by the Indians to be worked up into agricultural and other implements. While I was living in the neighborhood of the valley of Toluca, I was informed that specimens

of meteoric iron were to be found at Toluca. But I found no such specimens there, and afterwards learned, while sojourning in the mountains of Zacatecas, that it was found in the vicinity of Xiquipilco and much used there. Despite all my efforts, however, it was no longer possible for me to obtain a piece of it. From the length of time during which iron from this source had been sought and utilized by individuals for their own needs, and from the number of specimens carried away for scientific collections; and from the fact that notwithstanding all this, new specimens are continually being found, among which have been secured masses of a few ounces weight up to several hundred weight, I conclude that the Xiquipilco iron must have originated from several aerolites of one and the same fall, rather than from one huge one, such as would have been necessary to furnish all the meteoric iron that has been obtained here.

The Xiquipilco iron is found distributed over a considerable territory. G. A. Stein, who studied the region most recently, stated that they were scattered over a strip of territory almost 3 miles long, extending in the direction of northeast and southwest. They were found on the hills to the north and south of the town, sometimes in the loam of the hillside, and sometimes under the rubble of the ravines, where the water is so inconsiderable that it could not move the heavy meteoric iron masses. From this fact it is evident that such masses were found just where they fell.

Neither Sonneschmid nor Humboldt mentions the Xiquipilco iron, hence references to the accounts of the former, and also to those of Partsch and Clark concerning this specimen are incorrect. Humboldt, however, knew the locality in question, since there are specimens in the Berlin and Vienna collections which he brought with him. The Berlin University collection contains, besides the specimens brought by Humboldt, another of almost 14 ounces weight, which was sent by Gerolt. Wilhelm Stein sent specimens of the Xiquipilco iron to Europe in 1826, and later G. A. Stein sent Professor Wöhler another piece. This was analyzed by Uricoechea, who found schreibersite, olivine, and grains of a milk-white, a clear glistening, a ruby-red, and a sky-blue mineral. Finally, Stein brought to Europe a 21-pound mass and a larger piece of 233 pounds weight. This latter is 1 foot 9 inches long, 1 foot wide, and 7.5 inches in diameter, and was found in a small ravine by the name of Bata, half a league or a third of a mile from New Xiquipilco, under the stones of the brook. It formed a flattened roller, with a few tolerably sharp edges, corners and noticeable pittings. It is much oxidized upon the surface, in which troilite and schreibersite are visible. In the interior this iron had a coarse foliated crystalline structure, and fine Widmannstätten figures appear upon the polished and etched surfaces.

I also a short time before obtained a meteoric iron specimen from Xiquipilco of about 1 pound 6 ounces weight. This is entirely without crust, and may be only a fragment of a larger mass, as it shows over its entire exterior a coarsely foliated crystalline structure, such as usually is found on the fractured surface of meteoric iron. I found its specific gravity to be 7.07 to 7.10, while Rummler gave the specific gravity of Xiquipilco at 7.72, and Schreibers at 7.60 to 7.67. This difference may be due in part at least to the fact that the Vienna specimen, which Rummler and Schreibers employed, has been hammered. Krantz likewise obtained several pieces of the Toluca iron in 1854, one of which came from Istlahuaca (19 pounds weight), two others of 27 and 6 pounds weight, respectively, from Hocotitlan, and the last (43 pounds) from Tejupilco. These species have a more or less roundish form and are coated with a crust composed in part of a substance resembling pyrosiderite, although harder, from which it may be inferred that these masses were of their present size when they fell and were not broken up by the hand of man. The crust is one-eighth to one-sixth inch thick, but it is still thicker and readily detachable in the case of Istlahuaca. Considerable iron sulphide is found in these pieces, which may be distinguished upon the section surface by their more yellowish color compared with the almost tin-white color of the iron, and by the fact that it alters quickly in the atmosphere, producing specks and brown efflorescences which darken the polished and etched surfaces. On etching this iron yields fine Widmannstätten figures in broad hatched ribbons which cross each other in three directions, forming three and four sided areas, and separated from one another by small, smooth shiny threads. The latter appear quite distinctly on a well-polished surface of a brown or blue cast, since they appear very clearly upon the blue ground as small gold-colored lines with a metallic luster, which now divide the stripes from one another, and again encircle the areas and give the surface a very pleasing appearance.

The specific gravity of the specimen from Istlahuaca is 7.382, that from Tejupilco 7.326.

The locality of the first two of Doctor Krantz's specimens is given as Ixtlahuaca and Hocotitlan, the former on the road from Mexico to Valnadolid directly on Lerma Creek, the other not far to the northeast therefrom on the eastern valley slope. I visited both these places, as their situation at a slight distance from Xiquipilco was well known and is marked on his map of the region accompanying his book on Mexico. The situation of the third, according to the data on the label, is indicated at Tejupilco near Toluca. But both G. A. Stein and myself failed to locate such a spot. It is possible that the giving of these places as localities for meteoric iron may be due to a mistake in writing the names Xiquipilco and Jiquipilco, since the large Indian village of Tejupilco lies 4 miles removed from the mining village of Temascaltepec, and 15 miles south from Istlahuaca, accordingly far removed from the Toluca valley. But there is no known occurrence of meteoric iron at this place as yet, at least so far as known to me.

Whether the masses of meteoric iron designated by the name of Istlahuaca and Hocotitlan were actually found in the vicinity of these villages, or much more probably were found by Indians from that neighborhood while hunting at Xiquipilco and were brought back to their home town and then merely purchased by those at Istlahuaca and Hocotitlan I do not venture to decide, but I think the latter is the probable fact. If the before-mentioned masses of meteoric iron and all those which have been found, wrought into utensils, and carried away from the neighborhood of Xiquipilco during the last 70 or 80 years all belong to one and the same aerolite, it must be one of the largest, if not the largest, ever known.

The following table gives analyses of the Toluca irons by Uricoechea and Boecking:

	Uricoechea.	Boecking.		
	Xiquipilco.	Xiquipilco.	Ixtlahuaca.	Tejupilco.
Fe	90.400	86.073	89.073	87.092
Ni	5.020	9.016	7.290	9.801
Co	0.040	0.769	0.978	0.766
Schreibersite	2.990	1.009	0.972	0.730
P	0.160	.....	.....	.....
S	.....	0.394	0.855	0.790
Cu	trace	trace	trace	0.009
Cr	.....	trace	.....	.....
Sn	trace	.....	.....	.....
Mn	trace	trace	trace	.....
Insoluble	1.110	0.973	0.039	0.022
	99.720	98.234	99.207	99.204

The insoluble part of this meteorite consists, according to Uricoechea, as already indicated above, of olivine and of a milk-white, a clear glistening, a ruby red, and a transparent sky-blue mineral. But according to Boecking: (1) In the case of Xiquipilco, it consists of a white and bright yellow, shading to reddish mineral substance, entirely free from graphite flakes; (2) in the case of Ixtlahuaca, it consists of a yellowish mineral, apparently olivine, and of graphite scales; and (3) in the case of Tejupilco, for the most part of small yellow crystalline fragments and a very small quantity of graphite flakes.

According to a communication by G. A. Stein, an early publication of the results of an investigation of the large iron mass brought over by Stein may be expected from Professor Wöhler.

Wöhler [15] gave the following data:

Nowhere on earth have so many masses of meteoric iron been found in one and the same neighborhood as in the valley of Toluca in Mexico. They have been known, as Partsch stated, since 1784 from notices in the Gazeta di Mexico. The time of their fall is unknown. Concerning their locality, where they were found, many perplexities and mistakes prevail, and the names of many places in that region have been given as the locality of the masses in question (most frequently Xiquipilco and Ixtlahuaca); at all events there can be no question that all these masses originated from one meteor.

The latest and most trustworthy description of this iron mass is due to Mr. G. A. Stein, of Darmstadt, who owns mines and smelting works in Mexico and who had opportunity during a stay of several years to collect exact information concerning the occurrence of this iron and to possess himself of four of these masses, which he brought to Europe with him. One weighed 5.5 pounds and is at present in the possession of Doctor Jordan, of Saarbrück, and which he described to me as a still intact, compact, and elongated drop. Of the three other masses, one weighed originally 13 pounds, the other 19.5 pounds, and the third 220 pounds. I obtained from Stein some very fine large fragments which he had cut off from these specimens with the wish that I should employ these carefully collected shavings for the determination of the constituents of this iron mass. The results of the analysis of the 13-pound mass made by Doctor Uricoechea under my direction have already been given. The analyses of the other two masses were recently undertaken in my laboratory by Doctor Pugh, of Philadelphia. First, however, will be given the interesting description by Stein concerning the occurrence of these masses, as he communicated it to me:

"Since I had often heard of meteoric iron which, according to report, had been found in several localities of the valley of Toluca, I traveled in person, in July, 1854, in order to obtain definite information concerning the matter, to Ixtlahuaca, a small town on the right bank of the Rio de Leruca, or Santiago, not far from 10 leagues north of Toluca. After I had collected the desired information concerning the same I wended my way to the Hacienda Mañi, which lies on the west fork of the range of mountains which bounds the valley of Toluca on the east. The hacienda is 4 leagues east of Ixtlahuaca, 8 leagues east by northeast from Toluca and belongs to the diocese of an Indian priest town which lies about a league therefrom, by the name of Jiquipilco or Xiquipilco. In the barns of the proprietors of the hacienda was found the 220-pound piece of meteoric iron, which I forthwith bought after I had previously obtained the other masses from the same man, Ordoñez by name, through the medium of a friend. Concerning the finding of these masses Ordoñez stated as follows:

"'The largest was found about 15 years before in a small glen called by the name of Bata, 0.5 league southward from New Jiquipilco (there are two towns by this name, the old and the new, not far from each other) and 1.5 leagues southward from Mañi, among the rounded stones of the river bed, but not covered with them. The brook had almost no water in the dry season and very little in the rainy season. The iron mass can not, accordingly, have rolled far away, but must have fallen in the neighborhood of where it was found, which was further evidenced by the fact that it retained tolerably sharp angles.

"'The 19.5-pound mass was found 0.25 league northeast of Mañi upon an elevation in a stony-clay soil, as well as another piece 0.375 league east of Mañi. In the same glen where the largest one was found, although not in the same river bed, the 5.5-pound mass was found by myself, as I accidentally struck it with my foot in crossing. About one-third league east of this locality, about 20 years before, there is said to have been found an iron mass of about 300 pounds weight. From the same neighborhood came also the 13-pound mass.'

"A combination of these data shows that the line in which the various iron masses were found runs in the direction of south to north with a deviation to the eastward. It was told me that farther south, from the farthest point to the Hacienda Mayorazgo, even larger masses of such iron had long ago been found. The distance between the farthest points between which these meteoric irons were found I did not venture to determine exactly, still it is at least 2 leagues and probably more.

"A landowner of several years standing in the vicinity of Ixtlahuaca told me that the aforesaid iron masses were first heard of a long time before through a blacksmith who had worked the iron up into plowshares and axes without using steel. For a small reward he got the Indians to hunt for it for him, and he then worked it up in his shop. Iron was ordinarily very dear at that time. When my brother William was traveling through this same neighborhood in 1824 he obtained the same information from the dwellers there and acquired at that time a piece of meteoric iron of several pounds weight, which he sent to Europe. He does not know what has become of it. At present the larger as well as the smaller pieces have become scarce. In the passage of the years, however, a very considerable amount may have been worked up or carried away. It was brought to different places as merchandise, and it is doubtless due to this fact that meteoric iron was known here and there under various names—Ixtlahuaca, Tepetitlan, Mayorazgo, Gavia, Toluca, and Jiquipilco—places which all lie in the valley of Toluca, although it is always from the same identical Jiquipilco. Nöggerath has recently described a meteoric iron from Tejupilco, but I have no doubt that even this description originated from a confusion of the place names of Tejupilco and Jiquipilco. The former lies about 26 leagues southwesterly from Jiquipilco and only 9 leagues westerly from Arcos, my dwelling place. It is well known to me, but I have never heard anything from there to the effect that iron had been found in that vicinity. Likewise the masses of Mexican meteoric iron, which came into possession of Doctor Kranz and to which he assigned three different localities, are certainly all from Jiquipilco. These examples originate, so far as I know, from Emil Schleiden, in Mexico, with whom in former years I saw them, besides pieces and another mass about 15 pounds in weight."

I. *The 220-pound mass.*—According to the measurements of Mr. Stein it had a length of 54 cm., a breadth of 34 cm., and a thickness of 20 cm. The upper surface is more even than the underside, which is bellied in the middle, but both had several depressions of considerable size up to 5 cm. in depth and 8 cm. in width. The entire surface is much oxidized. In the 2-pound specimen which I received from Stein many yellowish scales of schreibersite with metallic luster may be noted in the oxidized crust. Besides, many drops of a yellowish liquid appear upon it, which is a solution of iron chloride such as is observed on many other meteorites. It does not show upon the polished section surface. The chlorine accordingly seems to come from outside by the oxidation of the surface.

This iron had a coarsely foliated crystalline fracture and after polishing and etching it shows Widmannstätten figures in great completeness and beauty, and with all the peculiarities so well described by Schreibers and Partsch in the case of the Elbogen iron, with which these Mexican specimens have great similarity. They are of unlike character in different places. Frequently the bands cut one another so as to form equilateral triangles. It is not passive.

Von Babo [16] analyzed a fragment of a specimen which weighed 237 grams which, according to Schleiden, of Trojes, in Mexico, "came from the neighborhood of Sizipilec, in the valley of Toluca, where similar pieces were found distributed over a considerable area and are frequently turned up by the Indians when plowing." His results were as follows:

Fe	91.89
Ni	6.32
Co	1.58
Mn	trace
	99.79

Krantz [17] had a special search made during the year 1856 for meteorites in the Toluca region. He says:

The result was not less than 69 entire specimens of meteoric iron. It is specially interesting to note that the masses are only small ones, the largest weighing only 1,725 and the smallest 58 grams. The 69 together weigh 49.5 kgs.

The oval form prevails among these specimens as to outward shape. A spheroidal form is shown by two, a very elongated stalactitic form by five, and a flat form by six. Almost all of the specimens show pittings which are so relatively large as to give the specimens a shell-like appearance.

With few exceptions the masses are altered upon the exterior and sometimes deep into the interior. Through this alteration, in two specimens, octahedral crystals come out distinctly.

As entirely new, however, the following were observed on several of the masses:

1. *Magnetite.*—This appears sometimes in dense particles, sometimes in small, sharp, brightly glistening octahedrons and dodecahedrons, crystallized out in drusy pittings upon the surface. Hydrous oxides were not found in it, and it is accordingly not to be regarded as a secondary formation, but of actual meteoric origin.

2. *Graphite.*—This occurred on three pieces in not very small dense particles, always in company with iron sulphide and penetrating deep into the interior with the latter.

Iron sulphide in large concretions and schreibersite in thin scales occur in considerable quantity in the fresh as well as the decomposed iron, being evenly distributed through the mass of the latter.

In order to examine the inner structure, several specimens were cut open, also a piece that had formerly been in an Indian oven, and which I had once more heated white hot; they all clearly showed Widmannstätten figures intersecting at angles of 60°. One of the pieces showed, besides the figures, a peculiar design composed of two parallel strips 4 cm. long and 3 mm. wide, with fine teeth on the edges and rounded at the end. They resembled graptolites. Similar peculiar divisions occur more frequently in an elongated mass of 1,201 grams, but they must be very flat, since in the other side of the section the design is less distinct and runs in an entirely different direction.

Reichenbach [18] gave the following observations:

Through the efforts of Stein, Krantz, Schleiden, Burkart, Ordoñez, and others, from 1784 down to the present time, a series of meteoric iron masses came to Europe, mostly to Germany, from the valley of Toluca, in Mexico, under the names Toluca, Tejupilco, Xiquipilco, Ixtlahuaca, etc. Some heavy masses were earlier found there, and more recently Professor Krantz, of Bonn, instituted a careful search and obtained not less than 73 small iron meteorites from this expedition. There has for a long time been disagreement as to whether these iron masses, which have been found scattered along for a mile or more, belong to several or to only one fall. The doubt concerning this point has now subsided.

I recently received a slice of such an iron which Herr Krantz permitted to be taken from a 42-pound mass from which he had given many specimens under the name of Tejupilco to the European collections. It weighed something over 2 pounds. It contained large specks of bright-yellow and pale-yellow iron sulphide; graphite was present; and Widmannstätten figures intersecting at angles of 60° made their appearance, after etching, upon the entire surface of the section. These things, however, are common and well known.

But upon examination I came upon something unusual. There appeared embedded in the iron quite large fragments of a stony material, sometimes of a dark-gray color with yellowish transparent specks, sometimes of a yellowish-brown color, coarse-grained, and harder than quartz but not so hard as topaz, which from its exterior appearance resembles olivine. By dissolving different iron meteorites in acid, there has frequently been obtained a residue of fine insoluble granules which must have been disseminated through the iron; but here alone are found large stony masses in iron, such as have never been seen before, angular fragments of 10, 14, and even 40 mm. in diameter and likewise of nearly 1.5 inches in length. I give a drawing of it in which the speckled portion of the section indicates olivine and the hatched portion, iron sulphide.

I also recently purchased of Mr. G. A. Stein, of Darmstadt, a beautiful meteorite from the Toluca Valley of almost 17 pounds weight. It weighed originally 19.5 pounds and came from the neighborhood of the Hacienda Mañi. A fragment of 2.5 pounds was partly filed and partly broken off. The fracture and section surfaces did not appear metallic all over, but were for the most part dull, stony, and blue gray. Carefully examined, this proved to be neither iron, graphite, nor iron sulphide, but evidently a substance interspersed with white and yellow grains, and corresponding exactly to the olivinelike particles in the above meteorite from Tejupilco. Here occurred the phenomenon of jagged conglomeration in an area 63 mm. in width and almost 2.5 inches in length.

I also had a 9.5-pound piece of a meteoric iron which I obtained from Stein and which was broken from a 230-pound mass sold to him by Ordoñez, who found it in Bata, a side ravine of the Toluca Valley. Olivine also appeared interspersed in this specimen, not so abundantly, but quite as distinctly showing the same characteristics.

Finally, I also owned a few small meteoric irons from the Toluca Valley which I obtained from Krantz, with Ixtlahuaca indicated as the locality of discovery, one weighing 3 pounds, another 2 pounds, and several of 1 pound weight. These I was loath to cut up, as they were entire aerolites, but all showed indications upon the crust of inclusions consisting, not of iron, but of a stony substance.

We have therefore secured, particularly for the special knowledge of the Toluca meteorites, a common peculiarity which binds together in an especial manner all those which, either entire or in part, have come into my possession and which gives to them a common character. It accordingly permits us to conclude inductively that it is more or less true of all of the Toluca iron masses. And it follows further that these closely related, rusty meteoric iron masses possessing a character so peculiar and found in no other known aerolites, undoubtedly belong to one and the same meteor and meteoric shower.

But for the general knowledge of the total history of the aerolites, these phenomena are also noteworthy. They show us for the first time with distinctness that larger particles of stone may and do occur in iron masses. This has never before been observed; the Toluca iron is the first known meteorite which occurs in this form.

In my last two notices I have shown that there are meteoric stones in which independent iron globules occur inlaid as meteorites in meteorites. Here we have the reverse condition: Meteoric iron masses in which independent lumps of stone occur inlaid or included as meteorites in meteorites.

Wöhler [19] gave the following analysis:

To the numerous meteoric irons which have been found in Mexico and described and analyzed, another as yet undescribed mass is to be added, which was brought to Europe by Schleiden, and came into my possession. It weighed 2,750 grams (5.5 pounds) and is an entire individual. It had a roundish, somewhat wedge-shaped form. The exterior is much oxidized. The polished section surface yields upon etching very fine sharply defined figures, with fine inclosing filaments of brightly glistening schreibersite, quite similar to the iron from the 223-pound mass of Stein's. It is not passive.

According to Martius, jr., its analysis is as follows:

Fe	89.22
NiCo	9.51
P	0.20
Schreibersite	0.06
C. and white mineral	0.24
	99.23

Rose [20] described an occurrence of quartz in Toluca, as follows:

Nagel, in a specimen of the Xiquipilco iron in his distinguished collection, recently observed a small crystalline point jutting out through the oxidized crust, which upon freeing it a little more, appeared as a four-faced projection with glistening surfaces. This he brought to me for closer examination and determination of the embedded crystal, and permitted me to remove the crystal from the brown iron oxide and preserve it in the Royal Museum. A small fragment of another crystal, which stuck beside this one in the crust, but which was broken in the removal, Nagel also gave me for investigation.

When the crystal was removed from the matrix it left a smooth-faced impression. It was only one-third line in size, yet, despite its smallness, not only could its form be determined as that of a hexagon-dodecahedron, but even its angles could be measured with considerable exactness. These angles were 103° 35.40′, 103° 25.49′, and 133° 30.42′. In the case of quartz the same angles measure 103° 34′ and 133° 44′. The crystal is accordingly quartz, and likewise the broken fragment of the crystal which was embedded near the former, since before the blowpipe it melted to a clear glass.

Moreover, quartz crystals are seldom found in the sand, and quartz sand is probably not present at all in the Toluca region, since the surrounding mountains are composed of a quartzless trachyte or recent volcanic stone.

I also found small quartzlike grains upon the exterior of another Toluca iron, but unfortunately they were lost. The quartz crystals appear to occur only very seldom on the Toluca irons.

Reichenbach [21] gave the following further observations:

Toluca gives the only case I know of in which a fusion crust collected pure and remained observable after many years. I have a meteoric-iron mass of the size of my fist and of a flattened cubic form in my collection from the valley of Toluca in Mexico. One large side had a rusty, scaly crust, like all old iron meteorites, the other on the contrary, although it had the same rusty color, did not consist of iron at all, did not resemble a meteorite at all in fact, but a dried mass of clay. It was full in all directions of crooked cracks under one-third of an inch in depth and was very hard, brittle, and sharp-angled. Nitric acid did not attack the polished surface of a detached fragment; a piece of fresh slag treated in the same way manifested the same appearance and the same behavior toward reagents, therefore the clayey mass is compacted fusion-crust material. Its agglomeration must have taken place in a peculiar way. The iron mass had received in falling, whereby it was broken into many pieces, a deep crack wide enough to lay one's finger in. In this crevice molten-crust material accidentally accumulated, filled parts of it completely, and upon cooling therein became a crooked hollowed old slag. The fracture of the half-severed piece is still distinctly visible. This fine enamel in several polished pieces is clear as crystal, dark brown, scratches glass, contains here and there scales of fine threadlike iron crystals, and is, within my knowledge, the only known example of a well-preserved molten meteoric-iron crust.

The yellowish-white iron sulphide is found well marked in Xiquipilco. Indeed, this iron meteorite contains, in predominant quantity, the equally well-marked bronze-colored iron sulphide, magnetic pyrites; the third form also occurs, the yellowish-white, and is clearly distinguished from the closely associated bronze-colored variety. Its individuality is not readily discerned when it occurs alone, but here it occurs with and in immediate proximity to the bronze-colored variety. Indeed it surrounds and incloses the latter, forms the transition member between the bronze-colored iron sulphide and the Trias, and spreads out farther in the latter. In the latter it forms specks and maintains its distinction in color from both the others.

* * * * * * * * *

Graphite is found more or less abundantly in lumps ranging from the size of a pea up to that of a walnut in Istlahuaca and Ocotitlan.

* * * * * * * * *

Graphite occurs as an accompaniment of magnetic pyrites in the case of Xiquipilco and in an especially well-marked degree in that of Ocotitlan.

* * * * * * * * *

Graphite occurs in lumps 2 inches in diameter embedded in the midst of the iron in the case of Ocotitlan.

* * * * * * * * *

I have a specimen of the Toluca iron about the size of a small fist which shows an excellent illustration of iron-glass in considerable quantity, lying in a wide-open crevice and largely filling the same.

* * * * * * * * *

Iron-glass occurs in a crack of Ocotitlan interlaced with the bands of kamacite and penetrating them.

Meunier [23] treated the crust of Toluca with bichloride of mercury, also with very dilute hydrochloric acid, and analyzed the portion removable by magnets with the following result (specific gravity 4.89):

Fe_2O_3	68.93
FeO	28.12
NiO	2.00
CoO	trace
	99.05

The presence of magnetite was thus indicated.

Rath [24] expressed the opinion that the crystals observed by Krantz were not magnetite. Smith [25] examined the troilite of Toluca for daubréelite and found it in marked quantities. He says:

> The residue from 2,800 grams of it, after thorough treatment with chlorhydric acid, which dissolves nearly the whole of it, was dissolved in part by nitric acid, and on analysis the solution was found to contain chromium and iron representing about 60 milligrams of daubréelite. The mineral obtained from these troilites was of the pulverulent variety.

Smith [26] mentioned the occurrence of nodules (concretions) of troilite, schreibersite, and graphite in the Toluca meteorites; also of compound nodules of which a sufficient quantity could not be obtained for satisfactory examination.

Brezina,[28] in his 1885 catalogue, described Toluca as follows:

> The Toluca iron shows lamellæ 0.9 mm. in breadth and frequently has very numerous large troilite inclusions with or without graphite with which the scaly troilite sometimes alternates. Schreibersite, especially in the vicinity of the troilite, is often well but irregularly developed.

Ansdell and Dewar [29] tested a nodule of graphite from a Toluca iron for gaseous constituents with the following results (specific gravity, 2.26; occluded gases in volumes of graphite, 7.25):

CO_2	91.81
H	2.50
CH_4	5.40
N	0.10
	99.81

Flight [30] gave a photograph of a surface of the Toluca iron etched with bromine water.

Castillo [31] gave a list of what he states are "meteorites of one and the same fall found at San Juan de Xiquipilco, in the valley of Toluca." The list is as follows:

> Meteoric iron of Ocotlan, small fragment; meteoric iron of Tenango, small fragment; meteoric iron of Cerro de Santiago, near the Hacienda de la Gavia, small fragment; meteoric iron of the Sierra de Montealto, District of Xiquipilco, small fragment; meteoric iron of Hacienda de Mañi, District of Ixtlahuaca, small fragment.

Fletcher [32] gave abstracts of a number of accounts of the Toluca meteorites and regarded all iron meteorites that have been found in the States of Mexico and Morelos as probably belonging to this fall and artificially transported. He thus included Ameca, Amates, and Cuernavaca, which Castillo listed as separate falls, with Toluca. Later usage, however, follows Castillo in making Amates and Cuernavaca separate falls, Cuernavaca being a fine octahedrite.

Cohen and Weinschenk [33] made an elaborate investigation of a Toluca iron, as follows:

> A piece weighing 299.4 grams was treated for 14 weeks with 1 part of hydrochloric acid and 20 parts of water, the acid being frequently renewed. During solution the kamacite became covered occasionally with a dark layer which probably consisted of fine particles of separated carbon. The tænite on the other hand showed, during the whole treatment, no alteration whatever. The process of solution showed a continued development of hydrogen sulphide. After some time a deep hollow formed from which large crystals of schreibersite (about 2.5 grams) fell out. They were gathered at this point in a nested fashion. In their neighborhood the solution of the nickel iron took place considerably faster than in other portions of the plate where large schreibersite crystals were completely lacking. In order to facilitate the process of solution the loose tænite plates were from time to time removed. Occasionally tetrahedral, or more rarely rhombohedral pieces surrounded by tænite, were obtained—probably Flight's iron tetrahedrons. These were protected by their tænite covering from further action of the acid. As a rule, however, the tænite lamellæ separated so that the acids had free access to the kamacite, and finally a residue consisting only of the finest foliæ

remained. After removing all the large schreibersite crystals, tænite foliæ, and jagged pieces, there remained a nonmagnetic residue of 0.6031 grams, and magnetic particles weighing 1.9864 grams. Of the latter, 0.9099 gram were dissolved in copper ammonium chloride which showed that three parts consisted of jagged pieces and one part of tænite. The remaining 1.0765 grams consisted of grains and flakes of normal schreibersite mixed with long needles of rhabdite. The composition of the plate investigated was thus, as follows:

	Gr.	Per cent.
Soluble nickel iron	284.5920	95.05
Tænite	7.3428	2.45
Schreibersite and rhabdite	3.5072	1.17
Jagged pieces	2.9256	.98
Nonmagnetic residue	.6031	.35
Slime	.4493	
	299.4200	100.00

The nonmagnetic residue, composed of pieces of rust, carbon, and mineral grains, was treated with hydrochloric acid, heated, and again digested with hydrochloric acid. There remained after this treatment 0.0162 gram of grains and small crystals.

The collected solutions were next employed to determine the copper contained in the iron. This gave a value of 0.0113 per cent. Further qualitative testing of the hydrogen sulphide precipitate indicated an absence of tin and antimony. Finally a part of the solution containing 13.281 grams of nickel iron was tested for manganese with negative result.

Tænite.—This forms fine, isolated, very thin foliæ between 0.03 and 0.25 mm. in thickness. Many show a rhombic form with an angle of about 120°, and are in part broad (10 by 7 mm.) and in part small (12.5 by 3 mm.). The largest are in general also the thickest, though among the thinnest plates many are large. A second kind of appearance originates through the uniting of many foliæ in parallel pieces into bundles with thin plates of kamacite between; the latter being often only very slowly dissolved. Such bundles are, however, not so abundant nor so thick as they are, for example, in Glorieta Mountain. The lamellæ are abundant, though toothed into one another, so that after solution and separation they appear with small jagged edges and show toothed forms like many ilmenites. Frequently angular pieces project into the foliæ and their fine points bore through them like a needle, leaving a hole after solution. The color is tin-white passing to silver white and resembles closely that of pure quicksilver. They easily tarnish, however, to a brass or golden yellow. If by careful treatment with alcohol and ether and immediate drying they are secured completely fresh, they seem to resist very strongly the influence of the atmosphere. The tænite is flexible and at times somewhat elastic, especially in the thicker pieces. In order to determine the solubility the tænite was treated for 38 days with cold dilute hydrochloric acid. The result was as follows:

	Per cent.
1 HCl+5 aq	79.36
1 HCl+10 aq	68.13
1 HCl+20 aq	65.33

As the same material was employed in all three experiments above, it is possible that the plates if once attacked are less resistant, so that in more dilute solutions the solubility may be less than indicated above; also the acid acts for a short time only with its original concentration in the above experiments, since the easily soluble kamacite was quickly dissolved. It is also true that the finest tænite foliæ, especially tho seforming combs in the plessite, are wholly or at least in part dissolved, and therefore the tænite content is higher than is given in the above composition; hence, the tænite undoubtedly plays a smaller part in the composition as expressed above than would be indicated by a study of polished and etched surfaces. Moreover, the tænite is especially prominent in the latter case because of its lighter color and lively luster. The chemical composition of the tænite found by analysis was as follows (substance taken, 0.5303 gram):

Fe	Ni	Co	Cu	P	Fe, Ni P	
63.04	33.17	0.38	0.14	0.11	3.28	=100.12

Since the content of copper appeared uncommonly high, it was, after weighing as copper oxide, again dissolved and precipitated electrolytically. The second determination was only slightly lower than the first.

The undissolved residue consisted of grains, crystal fragments, and flakes of schreibersite, and of very delicately formed long needles of rhabdite.

Iron-nickel phosphide.—This occurs in two forms, as schreibersite and rhabdite. The first occurs in part as large prismatic or thick tabular crystals 5 mm in length of pure tin-white color, but changing to light-golden yellow. The opaque wavy surface hindered recognition of definite crystallographic habit. All single crystal faces appeared in the form of little facets. Many crystals are strongly hollow on the end, a feature so often seen in pyromorphite. One such was hollow in the interior and inclosed tænite. The schreibersite thus inclines to porous growth. The cleavage is very complete, even to a high degree of brittleness. If the crystals fall on paper they often break into little cube-like pieces. The cleavage perpendicular to the length seems somewhat more complete than in the two other directions—a behavior which indicates the orthorhombic system; that is, the crystals appear to be a combination of the

prism and base. The plates with conchoidal fracture show strong metallic luster. Analysis gave the following result (substance taken 0.4115 gram):

P	Fe	Ni	Co	Cu	
15.38	63.97	19.15	1.68	0.00	=100.18

Fe : Ni (Co) : P=2.3043 : 0.7156 : 1
Fe+Ni (Co) : P=3.0200 : 1

The second portion of the iron-nickel phosphide which was obtained by treatment of the fine magnetic residue with copper ammonium chloride is not a single product, but consists of grains, crystal fragments, and flakes of the same physical properties as the larger crystals and long needles of rhabdite. Since the latter could not be separated a chemical investigation was not undertaken, especially as Meunier had isolated microscopic sections of schreibersite and analyzed them with the following result:

Fe	Ni	Co	Mg	P	
57.11	28.35	trace	trace	15.01	=100.47

The nickel content is, of course, considerably higher here than we have obtained, but the relation 3.106 : 1 is about the same. In order to determine the solubility the mixture of schreibersite and rhabdite was treated for 35 days with cold hydrochloric acid of different concentration. The result was as follows:

	Per cent.
1 HCl+2 aq	22.59
1 HCl+5 aq	15.67
1 HCl+10 aq	9.65

Judgment of these results should be governed by the same rules as were given for tænite. The rhabdite shows manifold terminations as illustrated by sketches. The simple forms are the most abundant, those with reentrant angles rare. Different terminations of the two ends are so common that one is inclined to consider the crystals hemimorphic, but commonly there appears on one end a square face which may be due to cleavage. Apparently hemimorphic forms other than these are very few. It was not possible to obtain pure rhabdite for analysis, so that it must be yet uncertain whether it has the same composition as schreibersite or a different one. From the physical properties and appearance the former view seems to us the more probable.

Jagged pieces.—In comparison with other iron meteorites that we have studied, these pieces in Toluca are characterized by small dimensions and abundance. Differential interior structure of the kamacite is indicated. An incomplete analysis by Koestler gave:

Fe	93.28
Ni+Co (by difference)	6.48
C	0.24
P	0.00
	100.00

This indicates that the pieces consist of kamacite.

The grains and crystals separated from the nonmagnetic residue (0.0162 gr.) showed various characters when examined under the microscope. The size of the grains varies from 0.01 to 0.5 mm., though the largest are very rare. Most have a diameter of about 0.04 mm. The following more or less well characterized ingredients were obtained:

1. Predominant are colorless, transparent, completely rounded grains with bright interference colors. About 50 of these were isolated. They are in part rich in minute inclusions which, on low magnification, give the impression of turbid spots occasionally arranged in bands. Where they are larger one recognizes round pipelike forms, probably gas pores which may be accompanied by glass inclusions. Minute microlites were once observed. Determination of the specific gravity gave 2.652. Three of the largest grains having a diameter of 0.2 to 0.3 mm. were investigated and brought into comparison with quartz grains of the same specific gravity. The solution was then exposed both to the rays of the sun and to shade and the grains simultaneously rose and sank. The grains furnished a silicate skeleton with salt of phosphorus; heated in a stream of oxygen they remained unaltered, but after 5 days' treatment with cold hydrofluoric acid were completely dissolved. The index of refraction is the same as that of quartz. Twelve grains treated with hydrofluosilicic acid left behind a small quantity of salts but apparently not more than a simultaneous blank experiment furnished. Thus it seems to be proved that these grains are quartz, since their total microscopic behavior is so similar that one could not distinguish between terrestrial quartz and that from iron meteorites.

2. The quartzlike grains were accompanied in some measure by other colorless transparent bodies distinguished from the former by their weak action in polarized light and resembling the grains isolated earlier by one of us, and determined by Magura to be diamond. Strongly heated in a stream of oxygen, however, their number was not diminished and they gave no turbidity with lime solution, hence diamond was not indicated.

3. Dull, white, opaque grains in large quantity, resembling a silicate strongly attacked by acid.

4. Fifty opaque single crystals or crystal groups with metallic luster, chiefly of dodecahedral or seldom with octahedral habit. The rounded faces in the latter case indicate hexoctahedrons. Often the crystalites (0.03 or 0.05 to 0.15 mm. in size) are arranged parallel to one another to form elongated groups similar to many growths of magnetite; also rhombic dodecahedrons arranged on a trigonal axis are common, which indicate a hexagonal combination of the

prism of the second order with a rhombohedron. In reflected light the crystals show a color and luster like graphite. Strongly heated before the blowpipe they show at first a moderately vigorous deflagration, and burning takes place slowly and uniformly until only minute transparent globules remain. These, therefore, are doubtless cliftonite, which, according to our view, is a pseudomorph of graphite after diamond.

5. Small, isolated, sharply-bounded crystals of chromite having a diameter of 0.015 mm. with strongly-reflecting faces. They appear bluish and transparent. Under the microscope generally only octahedrons occur. This appears in combination with the dodecahedron, occasionally also with the cube. The coloring and luster is similar to magnetite and lack of magnetism, brown transparent powder, reaction for chromium, and insolubility in aqua regia leave no doubt of the accuracy of the determination.

6. Two thick prismatic incompletely bounded crystal grains with strong interferemce colors and inclusions which appear to be glass. Spotted blue color. One crystal is in part colorless, in part deep blue. The strong pleochroism of the colored spots (deep blue and light blue tending to violet) make these crystals resemble iolite.

7. Isotropic, light flesh-red and brownish-red completely rounded garnetlike crystals $\frac{1}{2}$ mm. in size. These occasionally show some irregular clefts.

8. Dark brown isotropic grains with strong luster.

9. Transparent, colorless, isotropic splinters, with conchoidal fractures, which possess the index of refraction of the balsam. They are doubtless splinters of glass. They might be considered splinters of the glass vessels employed, but since they were observed in the residue we believe them to have been original constituents of the meteorite.

10. Light green anisotropic, incomplete prismatic augitic grains.

11. Fragments of light-green, somewhat fibrous, prismatic crystals with complete cleavage in the direction of their length, straight extinction, and weak pleochroism. The rays vibrating perpendicular to the direction of length are light green to yellow green, those parallel to the direction of length colorless to light yellow. This indicates probably an orthorhombic pyroxene containing iron.

Besides the plate of Toluca studied, 1,243 grams of rust crust and loose pieces were investigated. These were treated with 1 part hydrochloric acid and 10 parts of water and a considerable insoluble residue left. From this only traces of magnetic particles could be obtained. On the other hand it was rich in graphite about 15.5 grams (1.25 per cent) being obtained. A part of the graphite consisted of compact nodules 1 cm. in diameter; another of forms of cliftonite in crystal groups of octahedrons and cubes. Portions of both kinds were carefully separated under the microscope to a quantity of one or more decigrams and treated for 14 days with potassium chlorate and nitric acid, with repeated shaking and renewal of the oxidizing agents. The color changed gradually to greenish, that of the opaque variety more quickly than the cliftonite, and the final microscopic investigation showed that at least three-fourths of the substance employed was changed to a graphite acid, but no distinction between the two substances could be noted. The graphite acid formed in yellow transparent anisotropic, lath-shaped bodies arranged and extinguishing parallel to their length.

A further study was made the next year by Cohen [24] as follows:

As a continuation of my previous studies of Toluca, Mr. Manteuffel analyzed a solution of the iron (Analysis I) and the angular pieces (Analysis II). Under Ia and IIa are given the composition calculated to 100 after deduction of schreibersite. For determining the carbon in the angular pieces, 1.045 grams, and for that of copper and phosphorus in the solution, 284.59 and 10.6248 grams, were employed.

	I	Ia	II	IIa
Subst. taken	0.8854	.....	0.7702	.....
Fe	91.13	91.80	93.55	94.05
Ni	7.54	7.53	5.44	5.26
Co	.66	.66	.58	.57
Cu	.01	.01	.....	.....
C	.....	.....	.12	.12
P	.07	.....	.20	.....
	99.41	100.00	99.89	100.00

Taking the formula $Fe_{14}Ni$ as representing the formula of kamacite, Analysis I may be calculated to indicate the following composition:

Kamacite	94.89	or	Kamacite	95.33
Tænite	4.65		Tænite	4.67
Schreibersite	.46			
	100.00			100.00

Taking this analysis and the earlier ones, the mineralogical and chemical composition of the whole plate originally investigated, after deducting carbonaceous particles and rust, may be reckoned as follows:

	III	
Kamacite	90.51	91.48
Angular pieces	0.97	
Tænite		6.79
Schreibersite and rhabdite		1.73
		100.00

	IV	IVa
Fe	90.70	91.18
Ni	8.41	8.22
Co	.61	.59
Cu	.01	.01
P	.27	.....
	100.00	100.00

The results under IVa show the composition after deduction of schreibersite. The 2.35 per cent of tænite obtained by isolation after detucting 0.10 per cent for included nickel-iron phosphide totals only 34.61 per cent of the calculated total result.

Laspeyres [35] gave the following account of the detection of quartz and zircon in a specimen of Toluca:

The piece investigated was one of the largest of those collected by Krantz in 1856 in the Toluca valley, and weighed 10,030 grams. It showed on the rusted surface many irregularly bounded earthy portions sometimes 50 mm. in length and breadth, but always only a few millimeters thick, which at first glance resemble a very fine and somewhat loamy sand cemented by rust. In this almost compact carpet are embedded numerous brilliant quartz crystals reaching a size of 2 mm., as Rose has described. The earthy portions resemble many of the altered olivine nodules of meteorites and basalts, except that the latter lack quartz. The quartz crystals, as Rose has described, can be easily separated from the sandy matrix, but they can be more easily separated by dissolving the matrix in hydrochloric acid. They show the forms:

$$\infty\ R\ (10\bar{1}0),\ R\ (10\bar{1}1),-R\ (01\bar{1}1).$$

Like all silicates of meteorites this quartz is very fissile and brittle so that on scaling or loosening it easily falls into irregularly-bounded fragments. Measurements with the reflecting goniometer gave, for the unstriated rhombohedral faces, the following:

	Observed.	Calculated.
$R\ (10\bar{1}1)-R\ (10\bar{1}\bar{1})$	46° 5′–8′	45° 16′
$R\ (10\bar{1}1)\infty R\ (10\bar{1}1)$	37° 44′–47′	38° 13′

Neither with the lens nor under the microscope could any trace of a dulling or rolling of the corners or edges, or a scratching of the faces, be observed. Under the microscope the crystal form appeared (as is common to the crystals of meteoric irons, especially the well-known olivines in the Pallas irons) rounded on the corners and edges. The matrix in which the quartz was embedded was treated with hydrochloric acid and a solution of sodium carbonate. Iron, some clay, some magnesia, and silica were found in the solution. A very fine, seemingly sandy residue remained which was embedded in Canada balsam. On investigation with the microscope this showed that it was not a sand since there was no trace of erosion. The whole residue consisted of sharp cornered and edged grains, broadly prismatic flakes, and sharply-formed crystals. Still more, the mineral composition of the residue forbade its being regarded as a sand. The greater portion of the residue, about 60 per cent, consisted of colorless, transparent grains which belong not only to quartz but also to plagioclase and perhaps also to orthoclase. The latter show, besides a good cleavage, none of the twinning lamellæ which are so characteristic of plagioclase. They are also sharply bounded and in part also crumpled, as in terrestrial rocks. Besides these completely colorless splinters occur single weakly reddish transparent isotropic grains with traces of cleavage, more strongly refracting than quartz or glass and much weaker than the similarly colored zircon. These grains I can only refer to garnet. Glass grains, such as were observed by Cohen and Weinschenk, I could not find. The smaller portion, or 40 per cent, of the residue consisted of a brownish-green or green (though according to the thickness now bright and now dark) mineral in the form of partly irregular and partly broadly prismatic splinters with rectangular boundaries showing in their long dimension a very complete prismatic cleavage. The extinction corresponds usually with the direction of cleavage and also shows pleochroism in many of the lamellæ. Such belong, doubtless, to monoclinic augite, since in many pleochroitic splinters the extinction forms a sharp angle with the cleavage direction, and hornblende has not yet been observed in meteorites. No cross sections could be discovered. The most interesting constituent of the residue, however, was in the form of well-formed crystals rich in faces from 0.04 to 0.15 mm. long and 0.02 to 0.07 mm. thick. These, from their form and optical characters, can be nothing less than zircon, which has not been hitherto recognized in meteorites. The crystals are tetragonal and always show the same forms, as follows:

$$o\ (111),\ p\ (100),\ o'\ (101),\ q\ (110),\ d\ (m\ 11)$$

Some crystals are long and thin, others short and thick. They are always doubly terminated and show no trace of erosion. Measurement under the microscope gives:

(101) (101)=114° 30′, the calculated value being 114° 43′.

Cleavage like that of rutile could not be observed, and in one case there is excellent conchoidal fracture on one edge of the prism. The crystals are always light reddish, quite clear, and pure. They show a high index of refraction, with high interference colors, and the axis of the smallest elasticity is the principal axis. They thus agree completely with the microscopic zircons of terrestrial rocks. Single black crystalline sharply-bounded grains in the residue are perhaps chromite, or cliftonite—black plates, perhaps graphite. The olivine and anorthite which dissolve in acid should also be recognized as constituents of the sandy substance. In all the transparent constituents of the residue, but especially in the quartz, occur darkly bordered gas pores and small inclusions having a mean refraction between that of glass and a fluid. These always contain spherical bubbles, generally single but occasionally double, triple, or quadruple. Neither by shaking nor warming the Canada balsam to 32° C. did the position or size of these bubbles change. They belong, therefore, to the glass inclusions which are very abundant in meteorites, but which have not yet been known to contain a fluid inclusion.

Finally, in all the constituents of the residue, except in the supposed orthoclase and zircon, occur doubly refracting needles resembling in appearance the apatite needles of terrestrial rocks. It is true that apatite has not yet been proven to exist in meteorites, although Rammelsberg found 0.28 per cent phosphoric acid in the eukrite of Juvinas, which would correspond to 0.60 per cent of apatite. Since this eukrite contained almost no nickel iron which could unite with phosphorus, the occurrence of apatite in the meteorite seems probable. The form and mineral content of the residue described above leaves no doubt that it does not represent foreign matter but an original constituent of the meteoric iron. Of the substances found by Cohen and Weinschenk in Toluca, I was unable to find the following: Colorless transparent glass polarizing weakly; a cordieritelike mineral; dark-brown isotropic grains with strong luster; and transparent isotropic glass splinters. The essential differences between my observations and theirs lie, of course, in their failure to observe feldspar, zircon, and apatite; but the microlites which they describe as No. 1 may correspond to my apatite, and those which they mention as No. 2 to my orthoclase. On account of these differences, I dissolved a large quantity of the foliated rust which had accumulated from the crust by years in the museum, but obtained therefrom exactly the same solution and the same residue as from the sandy portions on the surface. In order to guard against the possibility that these portions of the crust had not formed in the natural position and had been mixed with sand, I dissolved in hydrochloric acid a piece of the Toluca iron from Krantz's collection weighing 82 grams, which was compact and solid, nearly surrounded by limonite but regularly penetrated by numerous tænite lamellæ. After about one-half of this had been dissolved the portion remaining showed many thin almost parallel streaks of clear, gray, granular, altered silicates, separated by silica which dissolved in caustic soda. These streaks had the shape and composition of the stony portion of the surface. In the solution were found again magnesia, iron, clay, and lime, indicating predominant olivine and some anorthite. The residue showed under the microscope the same contents as in the two other cases. Similar streaks were noted by Reichenbach in the Toluca iron. These he regarded as olivine and described and figured them. Similarly distributed silicates have also been observed in other meteoric irons. There thus exists no doubt that quartz and zircon and the other substances mentioned occur as original constituents of the Toluca iron, and it may be possible in time and by solution of a large quantity of the gradually accumulating rusts of the Toluca meteorite in the museum to establish by chemical analyses the existence of zircon and the supposed orthoclase and apatite.

Brezina,[36] in 1895, gave further observations on Toluca as follows:

To Toluca doubtless belong the irons from Amates, Ameca-Ameca, and Cuernavaca, which are placed here by Fletcher. Here also belong, according to a brief missive from Professor Klein, of Berlin, the Berlin museum specimens of Sierra Blanca, near Jiminez and Villa Neuva de Huejuquillo, found in 1784. In all probability, too, the iron from Rincon de Caparrosa belongs to Toluca, as well as that of Chilpanzingo, State of Guerrero. Castillo supposes that this lump of meteoric iron, originally weighing 341 grams, fell to earth as the result of the breaking up of a piece of chalcopyrite-bearing talc schist from Caparrosa. At the Paris Exposition of 1889, I examined this iron, as well as the mother stone from which it is said to have fallen out. The iron did not fit the hole exactly, but very nearly. While the iron is covered with a limonitish weathering crust and has suffered a comparatively widespread deformation and evening off of the exterior, through weathering, the surface of the hole in the mother stone shows no signs of this rusting-off process, which must have taken place inside of the cavity. From this fact it follows that the lump of iron could not well have come from the Caparrosa schist.

Apparently in connection with the schist formation a piece of stone fell to earth and a hitherto unnoticed lump of meteoric iron was picked up at that point, as many such from the Toluca find may have lain around in the collection of the mining school. The etching of a section of this lump of meteoric iron moreover, shows complete agreement with that of Toluca. Further, the small piece of the meteorite from Tule, Balleza, Chihuahua, found in the School of Mines, in Mexico, may belong to Toluca.

Of the specimens in the Vienna collection, the oldest one designated as Toluca, which is stated to have been acquired from Bergemann, in Berlin in 1810, certainly belongs to another locality. It has almost fine lamellæ and is throughout lustrous, with well-developed fields containing only dark plessite; it has also abundant tænite. This iron may belong to Morito, Pila, or Descubridora; the marked deformation, apparently due to dismemberment, makes a definite determination difficult. The study of numerous pieces of the Toluca iron gives many new phenomena;

compact lamellæ of cohenite or schreibersite being repeatedly observed in the kamacite. Outcroppings of schreibersite and graphite are sometimes combined in the same section in the most various ways, for example, pure graphite to pure troilite, through various admixtures of the two, now in zonal superimposed stratification, again in juxtaposed stratification, each one making a half lump, and again entirely mixed up; the lumps are frequently surrounded with a corona of schreibersite; in one case a graphite-troilite grain with a corona of schreibersite forms the nucleus for the upbuilding of a flat-faced schreibersite lamella 6 cm. long, parallel with the faces of an octahedron. Another section shows a ball of troilite of the size of a mustard seed surrounded by a twofold substance with a high degree of luster, and consisting apparently of cohenite and schreibersite, which is bordered on the outside, next to the kamacite, with a crystalline material.

Another section which is cut diagonally through a round, flat, smooth protuberance on the natural exterior of a fragment, shows upon etching the undisturbed penetration of the Trias into the protuberance. The gradual dissolving of large masses of the Toluca iron gives frequently very regular crystals or fragments of crystals of schreibersite. The sawed section, oriented according to the faces of a cube gives large tænite skeletons, on which the peculiar structure, the alternate preponderance of the one and the other octahedron in the development of the laminæ, may be very readily followed. Two specimens recently received by the Vienna museum, one designated as Zacatecas and the other in Baumhauer's collection, without indication of locality, both undoubtedly belong to Toluca. The latter shows long, straight, hatched, somewhat swollen bands 0.8 mm. wide; kamacite granular, slightly hatched, with numerous etching pits; fields gray, and full of combs; tænite well developed, especially on the swollen ends, as a triangular filling. Rhabdite is abundant in this specimen also. It has great similarity with that of Hacienda Mañi. A piece of the latter shows the kamacite granular as in Carthage, but not hatched.

Cohen [37] found Toluca irons capable of acquiring strong, permanent magnetism. The tænite he found to easily acquire permanent magnetism, to show no marked change on heating, and to retain the magnetism a considerable time. The cohenite and schreibersite were less easily magnetized and lost their magnetism quicker. No polar magnetism could be observed on the tænite of Toluca.

The specific gravity of specimens of the Toluca iron he found to be 7.794 at 15.8° C.; of the schreibersite, 7.1118 at 18.8° C.; and of the tænite, 7.6122 at 17.6°. On exhausting the air from the tænite different values for the specific gravity were obtained. Thus when the air was not at all exhausted the value found was 6.8; on exhausting 2 hours, 7.5022; and on exhausting 4 hours, 7.6122. Thus a lamellar structure of the tænite is indicated.

Cohen [38] gave the following account of a study of some apparent cohenite crystals in Toluca:

On one end of a section of Toluca iron in the collection of the University of Freiberg, in immediate connection with the original, rust-covered surface, occur large numbers of crystals in kamacite, which, according to their physical characteristics and appearance, correspond with the crystals of cohenite in Magura, Wichita, and Beaconsfield. Since neither this series of accessory ingredients nor the presence of cohenite in Toluca iron was known to me, I isolated with dilute hydrochloric acid a few crystals, which from their appearance seemed to be of exactly the same sort. Contrary to expectation, I found one portion to consist of cohenite and another part of schreibersite. From which it appears that these two minerals can not be differentiated with certainty either by their physical characteristics or the manner of their occurrence.

Cohen [39] gave a further description of a specimen of Toluca, as follows:

I received as a gift from Dr. Naumann a gift of a rust-covered specimen of the Toluca iron weighing 1,700 grams, the etched section of which gives so complete an agreement with numerous specimens of the Toluca iron as to make the determination of the locality of the mass under consideration quite certain, but it shows sufficient difference in the finer structure of the bands to call for brief description.

While in general, extensive and deep hatching, accompanied by comparatively large and deep etching pits, may be regarded as especially characteristic of the kamacite of the Toluca irons, yet in this case both the hatching and etching pits are very inconspicuous. On the first two sections, which were cut from one end of the elongated meteorite, they are entirely wanting; on the next two sections they are scarce, being either confined to individual bands or neither so numerous nor so deep as in normal Toluca iron. Instead, the bands are spotted, usually without but sometimes with granulation; especially in the former case the spots appear indistinctly defined. The oriented sheen is very marked, and the tænite fully developed, as is usually the case.

From these four sections it is apparently possible that the interior of the mass has the normal structure; but I did not consider proof of this of sufficient importance to warrant cutting the mass through the center. No evidence of an altered zone is furnished by the section under consideration, which is a complete cross section almost 4 cm. thick, having the same appearance in the central portion as at the borders.

Brezina has frequently observed a like abnormal development of Toluca iron. He mentions a piece from the Baumhauer collection with granular slightly-hatched kamacite; from the Hacienda Mañi, a granular kamacite, comparable to that of Carthage; and, according to a brief communication, there is a section in the collection of the Mar-

quis de Vibraye, upon which hatching and etch-pitting are entirely absent. The two latter pieces I was, through the kindness of Dr. Berwerth, enabled to compare with the Naumann section. In the Vibrayan section the bands are short, swollen, not bunched, and granular; one portion is spotted, another shows a distinctly fine-grained structure. The gray, finely-grained spaces are without combs, but frequently contain fine bright spangles in the central aggregate.

The Hacienda Mañi specimen shows a composition mainly of long bands, often bunched together and accompanied, in smaller measure, by short, swollen bands; the bright fields of considerable size abound in combs evidently produced by tænite. The kamacite is more or less abundantly granulated, occasionally spotted and throughout rich in etched pittings, while hatching is entirely wanting. The kamacite is not like that of Carthage, with which Brezina compares it. In my specimen of Carthage the kamacite is fine-grained, resembling that of La Caille, Misteca, Marshall County, and Fort Pierre, and is not divided by coarse furrows into larger grains.

The divergence of this section from normal Toluca iron is thus quite considerable; but the doubt concerning the correctness of the place of discovery has been materially diminished by the piece obtained from Dr. Naumann, as the latter furnishes an intermediate link.

My investigation of the Forsyth County meteorite showed that no inconsiderable difference in structure may be found in one and the same mass, and it is not always confined to small areas as is the case in Floyd Mountain, Linnville, Hollands Store, Carlton, etc. Toluca is an example of similar differences in different portions of the same fall.

Cohen [40] gave the following analysis of cliftonite from Toluca, the occurrence of which was mentioned by him in 1891.[35]

The carefully separated fragments chosen for analysis had a specific gravity between 1.994 and 2.196, the material not admitting of a more definite determination. It does not deflagrate with potassium nitrate. The analysis by Dr. J. Fahrenhorst gave:

Substance taken	0.1297	0.1093
C	94.48	94.44
H	.40	.33
SiO_2	5.12	5.01
	100.00	99.78

In the first analysis the determination of carbon failed owing to the incomplete burning of the graphite. The whole unburned residue was regarded as silica. In the second analysis this residue being of pure white color was also regarded as silica but not further determined. Owing to the minute dimensions of the cubes and octahedrons which predominate in the compact cliftonite (the cubes as a rule measuring only 0.04–0.05 mm. on an edge) crystals could not be selected for the analysis. It is undetermined therefore, whether they are of purer graphite than the compact groundmass.

The Toluca meteorites are widely distributed among collections. The Vienna Museum possesses 120 kgs., the British Museum 106 kgs., Hamburg 114 kgs., and the Field Museum 177 kgs.

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TOMATLAN.

Jalisco, Mexico.
Here also Fomatlán, Gargantillo, and Tulisca.
Latitude 20° 11′ N., longitude 104° 54′ W.
Stone. Spherical chondrite (Cc) of Brezina; Montréjite (type 38, subtype 1) of Meunier.
Fell September 17, 1879.
Weight, several stones, the largest not far from 1 kg. (2 lbs.).

This meteorite was described by Shepard [1] as follows:

For my knowledge of the Fomatlán meteorite I am indebted to Mr. Carlos F. de Landero, engineer, of Guadalajara, Mexico. Along with a fragment weighing 142 grams came his letter of March 11, stating that it formed a portion of a stone that fell "about the end of the year 1883 on the farm of El Garganitello, near the coast in the State of Jalisco."

The fragment is somewhat prismatic in shape, 2.5 inches long and 1.5 inches in each of its two other dimensions. The broadest side retains the original black crust, which is rough and dull, with a thickness rather above the average in meteoric stones. It is broken with medium facility, showing a rather lighter color than common in these bodies. It abounds in pisiform grains of a pearl-gray or brownish color, varying in size from a pea downward to that of mustard seed. The larger of these may be described as not strictly pisiform but rather flattened globules or imperfect crystals, with rounded edges and angles. They often exhibit a single tolerably distinct cleavage in one direction, the traces of another perpendicular thereto.

The basis in which the globules are imbedded is rather peculiar. It is many shades lighter in color than the globules, and is fine granular resembling certain massive albites. Under the lens it appears an intimate mixture of the broken gray globules and a white mineral. This last in the field of the compound microscope is seen to consist of sharply crystalline, transparent, or semitransparent grains, and closely resembles the chladnite of the Bishopville meteorite. It should be mentioned that the pisiform globules situated within an inch of the crust are much stained with iron rust.

But the striking peculiarity of the Jalisco stone is the prevalence everywhere of octahedral crystals of nickeliferous iron. These are so distinct as to be recognizable with the naked eye, the brilliant equilateral triangular faces coming into view by every change of position in the specimen. Now and then a surface presents a pitted or dissected appearance similar to what is common in quartz crystals. One or two instances were noted where a tendency to the arborescent structure showed itself, the octahedra being aggregated in a common line, and only touching by the tips of their pyramids. Neither the irregular globular form or the twisted pisiform shape of the substance, sometimes visible in meteoric stones, is recognizable in the present case.

This observation at first led me to suppose that the Jalisco stone offered the first instance of well-defined crystals of nickeliferous iron. But on recurring to the stones of several other localities, I find their presence is by no means rare, although they have not hitherto attracted attention. The following of those showing occasional crystals may be instanced: Rochester, Sumner County, Little Piney, Richmond, Yorkshire, Montrejean, Daniels Kuill, New Concord, Vouillé, Erxleben, and Affianello.

The crystals are uniformly distributed, penetrating even to the center of the chrysolite globules, and are often so minute as to be invisible without the aid of a glass. To effect their entire separation by the magnet is wholly impossible. Neither can their estimation be accomplished by the aid of acids, since the chrysolite is more or less decomposed by the same action that dissolves the crystals. The nearest approximation to their percentage, as determined mechanically, gave it about 7 per cent, though this is probably too high, through the adhesion of the pulverized chrysolite in the process of separation.

Particles of crystalline troilite of considerable size adhere occasionally to the nickeliferous iron, though on an average they can not exceed 0.5 per cent of the stone. The treatment of the metallic portion of the stone in aqua regia left undissolved a few very minute black shining scales of a plumbaginous nature together with equally minute nonmagnetic, dull, octahedral crystals of chromite, which gave with borax the characteristic chromium reaction.

Equally difficult, as in the case of the nickeliferous iron, is the dete mination of the proportions of the chrysolite and the supposed chladnite. The nearest estimate I can make would be eight of the former to one of the latter, thus presenting the following approximative table for the mineralogical constitution of the meteorite:

Chrysolite	80
Chladnite?	10
Nickeliferous iron	7
Troilite, Chromite, Peroxide of iron	3
	100

The specific gravity as determined upon two fragments, each having about one-third of its surface covered by crust, was 3.47 to 3.48.

In conclusion it may be observed that the shape of the specimen indicated it to have belonged to a stone several inches in diameter. Additional particulars relating to the fall will probably be furnished hereafter, through inquiries promised by Mr. Landero.

Addendum.

The delay which has occurred in the publication of the foregoing enables me to append thereto the very interesting extract from a letter of Mr. De Landero, dated Guadalajara, May 30, 1885:

"Respecting the exact date of the fall, I shall sooner or later be able to fix it with precision. The aerolite passed over the town of Fomatlán (40 miles south-southeast of Cape Corrientes, a village of 800 inhabitants, belonging to the canton of Maseota in our State of Jalisco, at a height of some three to five thousand feet, between 4 and 5 p. m. It was a very clear day. Many persons saw the aerolite and heard the explosion it made, which was very powerful. Its direction was from southeast to northwest. It left a white cloud in its track. Two or three fragments fell 8 miles northwest of Fomatlán between the houses of the Gargantillo farm. The latitude of Fomatlán is 19° 44′ north, and its longitude 6° 20′ west of the City of Mexico. Its elevation above the sea is about 100 feet.

"The administrator of the Gargantillo farm, Cesareo Rodriguez, gathered two or three fragments of the meteorite a few minutes after their fall, when they were still at a burning heat. The largest of these weighed about 2 pounds. The main body of the meteorite, which must have been very large, continued on its path to the northwest and fell into a large lagoon 4 or 5 miles distant from the farm.

"My uncle, Mr. Joaquin Castanos, who was at that time in Fomatlán, received one of the fragments from the hands of Cesareo Rodriguez, and kept it for me. I made a determination of the specific gravity of the meteorite upon a fragment weighing 28.5 grams, the result of which was 3.49."

A late letter gives September 17, 1879, as the time of fall.

The meteorite was at first known after Shepard's description by the name of Gargantillo, but as this was the name of the ranch alone the name was later changed to that of the town near by, of Tomatlan, erroneously spelled Fomatlan by Shepard. Castillo [2] gives it the name Gargantillo and the date of fall as September 17, 1879. Fletcher [3] first uses the name Tomatlan, since adopted as correct.

Brezina,[4] under the name Gargantillo, classes the meteorite as a spherical chondrite, Cc, and describes the Vienna specimen as follows:

Gargantillo has a very porous, friable groundmass, thick crust, large chondri, many brown flecks like Sarbanovac, the iron abundant with traces of crystal faces.

Wülfing [5] notes discrepancies in the date of fall given by different authors, some giving it as August. From the above records, however, there seems no reason to doubt the correctness of the date September 17.

Only 789 grams, according to Wülfing, are preserved in collections, and of this the Washington Shepard collection contains the largest amount, 511 grams.

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Tombigbee River. See De Sotoville.

TOMHANNOCK CREEK.

Rensselaer County, New York.
Here also Ironhannock Creek.
Latitude 42° 52′ N., longitude 73° 35′ W.
Stone. Brecciated gray chondrite (Cgb); Logronite (type 31) of Meunier.
Found about 1863; described 1887.
Weight, about 1.5 kgs. (3 lbs.).

This meteorite was first mentioned by Brezina [1] in his 1885 catalogue under the name of Ironhannock Creek. A fragment of 22 grams is described by him as follows:

Of a dark grayish-green color, resembling the dark green of Homestead. Somewhat lustrous in fracture, similar to the spherical chondrites. The crust scarcely distinguishable from the groundmass.

This fragment was presumably acquired by the Vienna Museum from Bailey, who in 1887 [2] gave the following further description of the meteorite:

Discovered about 1863 by Mr. H. Bancker, of Schaghticoke, New York, near the base of a large tree on the bank of the Tomhannock Creek in Rensselaer County. (About 15 years previous Mr. Bancker had found a similar stone in his swine yard, which, however, was lost sight of. The one under consideration was found quite a distance away from the house, whither he had removed the other one.)

This stone is very round, with an average diameter of 10 cm., and weighs about 1.5 kg. It was encircled with a zone of broad deep pittings. The crust is entire, except where a fragment has been broken off and a small crack probably caused by the blow of the hammer. The crust is of very uniform thickness, black, hard, thin, unglazed, but quite smooth, and scarcely thicker than stout note paper.

The freshly fractured surface shows a reddish-brown color, with a slight trace of blackish-green when held in a certain light; its texture is very fine, compact, and hard, and a little slaty in structure; shows no traces of iron even under the lens, but when cut with the diamond saw the iron appears in brilliant specks, like "pepper and salt" cloth.

The stone takes a high polish, which gives the surface a translucent, mottled appearance, with patches of clear seal brown, spots of a gray color, and a few "kugelchen" or grains of an oolitic structure.

In general the section surface resembles that of the Seres, Macedonia, stone.

Analysis of metallic portion by F. A. Wilber:

Metallic iron	13.02
Nickel	3.06

In 1895 Brezina [4] seems to have had cause to doubt the genuineness of the reported history of the meteorite, and concluded that it was a stone of the Homestead fall ascribed to the New York locality. He states his opinion as follows:

Tomhannock Creek should perhaps be withdrawn from the list of meteorites. In thin section the similarity of this stone with that of Homestead, in respect to their dark-green color, is very marked; they agree perfectly also in respect to the very peculiar composition of the crust, which can scarcely be distinguished from the groundmass. In America, moreover, there is a doubt as to the occurrence of a fall at that point. Here, also, doubtless belongs the Yorktown, New York, meteorite of 1869, of which Siemaschko obtained a fragment from Gregory. It is a rather dark-gray chondrite, which corresponds with the middle part of Homestead or the brighter portion of Tomhannock.

Meunier [5] classes Tomhannock Creek as logronite. Newton [3] lists the meteorite among those which show a lineal arrangement of the metallic grains.

At present the meteorite is generally regarded as a distinct fall and is so listed in most catalogues. The principal mass (1,345 grams) is in the possession of Bailey, but a number of grams are distributed.

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TONGANOXIE.

Leavenworth County, Kansas.
Latitude 39° 6′ N., longitude 95° 10′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1886; described 1891.
Weight, 11.5 kgs. (26 lbs.).

The first mention of this meteorite was by Snow,[1] as follows:

The year 1890 has brought to scientific knowledge a larger number of tangible celestial visitants than all preceding years combined. Up to this year the Waconda meteorite was the only representative from Kansas on the list of authentic meteoric falls. In March of this year the now famous group of irons from Kiowa County was made known to science; and on June 25, 1890, the Washington County aerolite was heard and seen to fall at midday by thousands of Kansas citizens; and now, just at the close of the year, I have the pleasure of announcing a third fall of unknown date. This may be called the Tonganoxie meteorite. So far as is now known, this fall consists of a single specimen, weighing 26.5 pounds. It is an iron of ordinary character (not a pallasite). It is of an irregular shape, and is thought by the owner to resemble a lion couchant. It is 9.75 inches long, 6.5 inches wide, and 3.5 inches deep.

This meteorite is the property of Mr. H. C. Fellows. * * * Mr. Fellows bought it in the spring of 1889 of Mr. Quincy Baldwin, who found it upon his farm, 1 mile west of Tonganoxie town, in 1886. Mr. Baldwin was not aware of its true character, although he had manufactured a fishhook from a small fragment of the iron. He considered it to be a piece of iron ore, and proposed to start an iron mine upon his farm; but this fragment proved to be the only "indication," and the mining project was reluctantly abandoned. This meteorite is now deposited in the museum of the University of Kansas, but is still the property of Mr. Fellows. A preliminary analysis shows the presence of iron, nickel, and cobalt. Prof. E. H. S. Bailey will soon publish a complete analysis.

A small portion of the surface has been polished, and exhibits very distinctly the Widmannstätten figures. Careful search has recently been made for other fragments of this meteorite on the Baldwin farm and vicinity, but without success.

Bailey[2] gave a further account and analysis, as follows:

Dr. F. H. Snow[1] published a preliminary notice in regard to the discovery of the Tonganoxie meteorite. The specimen was picked up in 1886 by Mr. Quincy Baldwin, on his farm a mile west of the town of Tonganoxie, Leavenworth County, Kansas. The true nature of the specimen was not understood by the original owner. He experimented with it so far as to make a fishhook from a fragment of it, and thought its occurrence was an indication that there was an iron mine on his farm. Since, however, he was unable to find any more specimens, the iron mine theory was abandoned. Mr. Baldwin disposed of the meteorite to Mr. H. C. Fellows, then principal of the Friends' Academy, in Tonganoxie, and from him it has been purchased by Doctor Snow, and it is now in the museum of the University of Kansas.

The specimen originally weighed a little over 26 pounds, but a slice has been cut from the smaller end, in order to obtain a plane surface that the structure might be studied, and the present weight is 23.25 pounds (10.55 kg.). Its shape is that of an irregular triangular pyramid; the length being 9.5 inches, the width 6.5 inches, and the depth 4.5 inches. The specific gravity is 7.45, as compared with water at its greatest density. This specific gravity was taken by weighing the whole meteorite.

As can be seen by an examination of an accompanying figure, the surface of the meteorite shows numerous depressions, some of them quite large. The entire exterior is covered with a reddish-black coating. This seems to be composed of scales of oxide of iron. These scales are brittle and readily attracted by the magnet. After the specimen had been for some time exposed to the air, after being handled, numerous droplets of chloride of iron appeared on the surface. These seem to exude from minute cracks or to come from under the scales. The occurrence of chloride of iron and its exuding in this way is by no means uncommon in meteorites. To the fact of its presence is probably due the great tendency to scale noticed above. This iron salt gradually changes to a brown friable oxide.

The analysis shows the following composition:

Iron	91.18
Nickel	7.93
Cobalt	0.39
Phosphorus	0.10
Copper	trace
	99.60

A test made for sulphur, on the same sample analyzed above, showed only a possible trace, but an examination was made of a sample of turnings, somewhat oxidized, and a very perceptible precipitate of barium sulphate was obtained. Scattered over the polished surface may be seen occasional long slender crystals, sometimes branching, also several nodular masses of a bronze color. These are without doubt troilite (iron-nickel sulphide). The larger particles are near the center of the polished end, as though the last to crystallize. The troilite can not be seen till the surface has been polished with oil and emery. As this mineral is so irregularly distributed there was probably only a very small quantity in the particular piece analyzed. The Widmannstätten figures came out very perfectly with nitric acid. * * * The octahedral form of crystallization is apparent, but it is not possible to distinguish the Neumann lines that are believed to indicate the cubic form of crystallization. It is, however, possible, as some observers have noted, that some other surface, if polished, would show this form. A crack extends across the surface on the etched side, and other small cracks lead into it. These are all filled with a black mineral, probably made up of the oxidized metals. The cracks in an irregular way follow the lines between the crystals.

On examining this meteorite with the magnetic needle, it was found that there are several distinct poles. Mr. A. G. Mayer has plotted the lines of magnetic force, so as to show their true relation. The position of the poles might be expected to be near the ends, but this is not the case in this specimen.

As the meteorite is irregular as described, and quite flat and comparatively free from cavities on one side, the question naturally arises, Is it not a fragment thrown off from a much larger mass? A careful examination of the mass will render such a theory, to say the least, very probable, but whether this mass was brought here by human or geologic agencies, or whether its companions still exist in the vicinity, it is at present impossible to state. A careful search in the vicinity of the farm where it was found fails to reveal any other specimens.

The meteorite is somewhat distributed, the University of Kansas possessing the main mass.

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TRAVIS COUNTY.

Texas.
Latitude 30° 20′ N., longitude 97° 43′ W.
Stone. Black chondrite (Cs), of Brezina.
Found ?; described 1890.
Weight, 2 kgs. (5 lbs.).

This meteorite was described by Eakins [1] as follows:

This meteorite was found in Travis County, Texas, and brought to notice by Prof. R. T. Hill, of the University of Texas, who presented the piece first obtained by him to the United States National Museum. This piece, of an irregular shape, and weighing about 2.5 kg., is supposed to be but a fragment of a much larger mass.

It has a superficial coating of a yellowish-brown color where it has been subjected to weathering, but on a fractured, unaltered surface it is dull black with a slight grayish tinge. It is hard, compact, and very tough; to the unaided eye the stony mass is very uniform in structure, and none of the composing silicates can be distinguished, but troilite can be plainly seen scattered through it, and on a polished surface the metallic particles are also visible. Under the microscope, the stony portion seems to consist chiefly of olivine and enstatite, with a small quantity of a colorless mineral, which is probably a feldspar; the analysis also indicates the presence of a feldspar, while chromite was also unmistakably present. The mass has a specific gravity of 3.543 at 30°, and its analysis as a whole is as follows:

SiO_2	44.75
Al_2O_3	2.72
Cr_2O_3	.52
Cu	trace
FeO	16.04
Fe	1.83
NiO	.52
Ni	.22
Co	.01
MnO	trace
CaO	2.23
MgO	27.93
K_2O	.13
Na_2O	1.13
P_2O_5	.41
S	1.83
H_2O	.84
	101.11
Less O for S	.92
	100.19

Analysis of the metallic portion extracted by an electromagnet and dissolved by copper sulphate gave:

Fe	Ni	Co	
88.74	10.68	58	=100.00

Further study of the soluble and insoluble silicates gave the following as the probable constitution of the meteorite:

Metallic	2.23
Troilite	5.03
Soluble in acids	39.84
Insoluble in acids	52.42
	99.52

Wülfing [2] inquired if this meteorite does not belong to the same fall as Bluff, and it seems not impossible that such is the case. The distance from Bluff to the border line of Travis County is only 40 miles and it is well known that pieces of the Bluff meteorite were widely distributed. The external appearance of the meteorites is also similar. The analysis of Travis County shows some differences from that of Bluff, especially a higher percentage of silica and the presence of alkalies.

Brezina,[3] in Ward's catalogue, classes Travis County as a black chondrite and Bluff as a brecciated crystalline chondrite. It is possible, therefore, that the differences are sufficient to warrant regarding the falls as separate.

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TRENTON.

Washington County, Wisconsin.
Here also Milwaukee, Washington County, 1858, and Wisconsin.
Latitude 43° 22′ N., longitude 88° 8′ W.
Iron. Medium octahedrite (Om), of Brezina; Caillite (type 18), of Meunier.
Found 1858; described 1869. Further masses found 1869, 1871.
Weight: Six masses weighing 65 kgs. (143 lbs.).

This meteorite was first described by Smith[1] as follows:

These meteorites were first brought to my notice by Mr. I. A. Lapham, of Wisconsin, and his attention was called to them by Mr. C. Daflinger, secretary of the German Natural History Society of Wisconsin. They were discovered in the town of Trenton, Washington County, Wisconsin, and I have called them the "Wisconsin meteorites." Up to the present time fragments have been found indicating that these meteorites were of the same fall and separated at no great elevation. They were found within a space of 10 or 12 yards, very near the north line of the 40-acre lot of Louis Korb, in latitude 43° 22′ north and longitude 88° 8′ west from Greenwich, and about 30 miles northwest of Milwaukee. They were so near the surface as to be turned up with the plow. They weigh respectively, 60, 16, 10, and 8 pounds and present the usual pitted and irregular surfaces. The largest of the meteorites in its extreme dimensions is 14 inches long, 8 inches wide, and 4 inches thick, weighing 62 pounds. Its specific gravity is 7.82 and composition:

Fe	Ni	Co	P	Cu	Insoluble	
91.03	7.20	0.53	0.14	trace	.45	=99.35

A polished surface when etched gives well-marked Widmannstätten figures. There is something, however, peculiar about the markings on this iron, which is doubtless common to other irons, but which has heretofore escaped my observation; and I can not discover, in a hasty investigation, that it has been noticed by others. My attention was called to this peculiarity by Mr. Lapham, on a slice of the meteorite I sent him etched. Should these markings be entitled to a separate notice, I propose calling them "Laphamite markings."

An analysis by Bode [2] gave the following results:

Fe	Ni	Co	P	
89.22	10.79	trace	0.69	=100.70

Specific gravity, 7.3272.

In 1872 Lapham [3] reported the discovery of two additional masses of the meteorite weighing, respectively, 16.25 and 33 pounds. These, he states, were found in the same field as the others.

In 1880 Brezina [4] noted the presence of Reichenbach lamellæ in the iron and illustrated the same. In 1885 he [6] further described the structure as follows:

Trenton has fine, short Reichenbach lamellæ, straight, swollen, slightly grouped, with oriented luster, neither striated nor spotted, fields and bands numerous, plessite not much darker than the kamacite. To Trenton also belongs a piece which Tschermak represented as a new locality, Milwaukee. Trenton lies near Milwaukee. No meteorite peculiar to this locality is in existence, the two masses, moreover, agree in the smallest details, and, moreover, it is evident from the outer form and direction of the lamellæ that the supposed Milwaukee specimen and this of Trenton are cut from the same original mass and from points very close together. Breadth of lamellæ, 0.9 mm.

Meunier [7] states that "the figure given by acids is remarkably regular and approaches closely that of Caille." Cohen [8] states that Smith's term of Laphamite markings was erroneously given to what had previously been described by Reichenbach as combs.

Cohen [9] found that the iron took on, more or less strongly, permanent magnetism.

The meteorite is distributed, although the whereabouts of only 24 kgs. are given by Wülfing. The University of Wisconsin is stated to have 10,400 grams and Harvard University 6,249 grams. In addition to the specimens reported by Wülfing the Milwaukee Museum has 22,049 grams, which includes four nearly complete individuals weighing 12,517, 3,586, 3,515, and 2,009 grams.

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Trinity County. See Canyon City.

Trinity County, New Mexico. See Glorieta Mountain.

Troy. See Bethlehem.

TUCSON.

Pima County, Arizona.

Here also Ainsa, Arizona, Cañada de Hierro, Carleton, Irwin, Muchachos, Ring Meteorite, Santa Rita, Signet meteorite, and Tuc.

Latitude, 32° 56′ N., longitude, 111° 10′ W.

Iron. Ataxite with accessory forsterite (D/T) of Cohen, Tucsonite (type 8) of Meunier.

Weight. Two masses, one of 688, the other 287 kgs. (1,514, 632 lbs.).

From the great mass of discussion regarding this meteorite the following summary may be given: Two masses of the meteorite are known, both found in a pass called Los Muchachos in the Santa Rita Mountains, about 30 miles southeast of Tucson, Arizona. The original date of the finding of these masses is not known but it may have been as early as the sixteenth century. One of the masses is ring-shaped and weighed originally 1,514 pounds (688 kg.). Of this, 1,400 pounds (635 kg.), or essentially the whole mass, is in the United States National Museum in Washington. This has been known by the names of Bartlett, Ainsa, Irwin, Ring Meteorite, Signet meteorite, Santa Rita, Tucson, and combinations of the above names. The other mass is elongated kidney-shaped and weighs 632 pounds (287 kg.). It is preserved practically entire in the museum of the California State Mining Bureau in San Francisco. It has been known under the names of Arizona, Carleton, Sierra de Santa Catarina, Tucson, and combinations of

these names. The names associated with the two masses are chiefly those of the localities where they were seen or obtained, or of parties who saw the masses or aided in their removal.

The first published mention of the meteorite seems to have been by Velasco [1] in 1850. His statement, as quoted by Fletcher, is as follows:

> Between the presidio of Tucson and Tubac is a mountain range called Sierra de la Madera and a pass called Puerto de los Muchachos. In it are seen enormous masses of native iron, and many have rolled to the foot of the said sierra. One of the masses of a moderate size was transported to Tucson and has stood for many years in the plaza (square) of the said presidio.

The next mention was by Dr. John L. Le Conte,[2] of Philadelphia, in an oral statement made by him at a meeting of the American Association for the Advancement of Science, held at Albany in August, 1851. Two accounts of this statement have been published. According to the first and brief official account, Dr. Le Conte, "while passing through the village of Tucson in the preceding February, had observed two large pieces of meteoric iron in use by the blacksmiths of the town as anvils." They were irregular in form, and although embedded in the ground to make them steady for use they were about 3 feet high. Notwithstanding the offer of a high price "he was unable to get any bits broken from the anvils, but was guided to a canyon between two mountain ridges in the immediate vicinity from which both pieces had been taken, where the masses of the meteorites were so abundant as to have given name to the canyon."

A year later, in July, 1852, the two large masses were seen at Tucson by John Russell Bartlett,[4] then the United States commissioner for the delimitation of the United States and Mexican frontier.

One, a ring-shaped mass, of which he gives a figure, was in use as an anvil in the blacksmith's shop. He wrote as follows:

> It was found about 20 miles distant toward Tobac, and about 8 miles from the road, where we were told are many larger masses. There is another mass within the garrison grounds, of which I did not take a sketch. With much labor Dr. Webb broke off a fragment of this meteorite for the purpose of analysis.

Bartlett described the exterior as smooth and even, the interior uneven in some parts and indented.

In November, 1854, Shepard [5] gave a description of some small fragments, the largest not more than a quarter of an ounce in weight, which had been sent by Lieut. John G. Parke, of the United States Topographical Engineers, on his return from Sonora. Parke had just been engaged in the survey for a railroad across the continent and had chipped off the fragments while at Tucson in February, 1854; he was told that there were three masses, though only the two larger ones were seen by him. According to information supplied by Parke they—

> were found in a cañada of the Santa Rita Mountain, about 25 or 30 miles to the south of Tucson. Two of them were shown to us by the commandante, both being used as anvils. One lies within the presidio, and is of a very peculiar form, being angular and somewhat like a seal ring of huge proportions. Its exterior diameter is about 3.5 feet; its interior about 2 feet. It weighs nearly 1,200 pounds. The other piece is in front of the Alcalde house. It weighs about 1,000 pounds and has an elongated prismatic form, serving well the purposes of an anvil. It is partially buried in the soil, but has 2 feet of its length projecting above the ground. The alcalde and commandante would not consent to our removing the masses, even if we had had the means.

Shepard observed numerous white inclusions as large as pin heads, which he regarded as chladnite (enstatite), and remarked that the silicate upon a polished surface first became noticeable after etching. He further noted the absence of crystalline structure, found the tough iron, resembling white cast iron in fracture, to be very resistant to acid, proved that it contained nickel and determined the specific gravity as 6.66.

Smith [6] investigated material obtained from Parke. He observed unusual development of Widmannstätten figures due to the filling of the hollows with silicates, and drops of iron chloride upon the crust. He also determined the specific gravity at 6.52 to 7.13 and from his analysis (see I below) derived the following composition:

Nickel iron	93.81
Chromite	0.41
Schreibersite	0.84
Olivine	5.06
	100.12

A few silicate grains were mechanically isolated and identified as olivine, which occurs as in the pallasite from Atacama, also in fine-grained aggregates.

In the same year Genth [7] published a chemical analysis; he announced that the iron was not passive, as Shepard had stated, and conjectured a small quantity of labradorite. The mean of three analyses by Genth follows under II.

It is not certain which of the two masses were used in the analyses by Smith and Genth.

Michler [8] named the locality of this meteorite Santa Rita (Santa Rica), and the mountain at the foot of which Tuscon is situated, he named Sierra de Santa Catarina.

In 1863, Brush [9] investigated a piece of the second mass mentioned and described by Parke as an elongated prism in form, which was brought to San Francisco by Gen. Carleton. The length of this mass was given as 124 cm. and the weight as 286¾ kg. According to Brush, the iron is active, has a specific gravity of 7.29, and appears flecked with particles of silicate; after treatment with acid there remains a residue composed of partially disintegrated olivine, schreibersite, and a trace of chromite. From this analysis (III below) the composition was estimated as 89.62 per cent nickel iron and 10.07 per cent olivine, and it was noted that the analysis of Smith, estimated in the same way, gave an olivine content of 8.70 per cent. Brush conjectured that the piece analyzed by Smith came from the ring-shaped mass, which he designated as the "Bartlett meteorite."

The above-mentioned analyses—I, Smith's; II, Genth's; and III, Brush's—are as follows:

	Fe	Ni	Co	Cu	P	Cr	Cr_2O_3	Al_2O_3	FeO	CaO	MgO	K_2O	Na_2O	SiO_2	Labradorite	O	
I..	85.54	8.55	0.61	0.03	0.12	0.00	0.21	trace	0.00	0.00	2.04	0.00	0.00	3.02	0.00	0.00	=100.12
II.	83.55	9.20	0.39	0.01	0.13	0.17	0.00	trace	0.00	0.51	2.26	0.10	0.17	3.01	1.05	0.00	=100.55
III	81.56	9.17	0.44	0.08	0.49	trace	0.00	trace	0.12	1.16	2.43	0.00	0.00	3.63	0.00	0.61	= 99.69

Rose [11] described a section in the Berlin collection obtained from Shepard as follows:

> The polished surface is full of small round cavities. After etching it shows coarse-grained composite patches, some of which in a certain light have a light gray, others a darker gray color; in other positions the shading is reversed. The composite patches have a very thin edging of tænite, and many of the small cavities have glazed walls, which are conspicuous upon the other dark surfaces. The composite surfaces show fine, linear, straight furrows, which have a character somewhat different from the etching lines.

Since the description agrees with those of others, except for the failure to mention the occurrence of silicate, it would appear that this had been eliminated in cutting or polishing the plate.

In the same year as Brush, Haidinger [15] described the mass brought by Carleton to San Francisco, under the name Carleton-Tucson and gave a reduced picture after a photograph taken by Whitney. He compared the flat dish-shaped or shield-shaped form of the meteorite with that of Hraschina and distinguished upon the specimen in the Vienna collection a smooth portion of the surface and a part provided with pittings, and conjectured that the former was the front part of the mass. Individual portions of ½ to 2 cm. in size show, according to Haidinger, distinct metallic sheen, as well as occasional fine twin lamellæ. He noted further, a sort of a schistose structure, which was especially noticeable upon the two lateral surfaces, but here curiously enough does not agree with their direction. The structure was described as granular as a whole and imperfectly schistose in part. The etched plate appears crowned with numerous, small stony particles, whose distribution is not entirely uniform. The meteorite, he thought, should be designated as a "granular iron-stone." In a brief communication to Haidinger, Richthofen gave the opinion that the analysis by Smith as well as that by Brush, related to the Carleton iron, since the Ainsa iron had a different mineralogical composition. It, he said, contains no olivine, but whitish crystalline grains, which he and Whitney regarded as anorthite. For the latter ring-shaped mass Haidinger used the name "Ainsa-Tucson-Meteorite."

In 1863, the ring-shaped mass, which after the removal of several pieces weighed 635 kgs., was also accessible, since it came as a gift to the Smithsonian Institution at Washington,

through the efforts of Irwin and the brothers Ainsa. Irwin [12], who had come into possession of the mass in 1857, while it lay uncovered in a street of Tucson, gave as the place of discovery, in accordance with the statement of the natives, the Santa Catarina Mountains. It was asserted that about 200 years before a fall of meteorites had taken place there and large masses of iron had been left by it. According to a brief notice by Santiago Ainsa,[12] the iron was long known to the Jesuits. He stated that in 1735 his great grandfather, Juan Baptista Ainsa, had visited the place of its discovery, Los Muchadios, in the Sierra de la Madera, with the view of transporting it to Spain. The mass was then brought to the garrison in the neighborhood of Tucson, and later into the city itself, where, for lack of means of transportation, it remained.

Henry,[13] the Secretary of the Smithsonian Institution, collected these reports in 1863, whereby he, in consequence of an error, changed the locality to Los Muchachos, in the Sierra Madre Mountains. He designated the block as the Ainsa meteorite; but in 1865 [16] he stated that in future it should bear the label, "Irwin-Ainsa Meteorite."

The kidney-shaped mass was taken possession of and sent to San Francisco in the year 1862 by Gen. James H. Carleton, who was in command of the column from California. He presented the mass to the city of San Francisco as a memento of the march of his column, and asked that it might be "placed upon the plaza, there to remain for the inspection of the people and for examination by the youth of the city forever." It was, however, deemed advisable to keep the specimen in a safer and drier place and it was, accordingly, removed to the museum of the Society of California Pioneers. This building was destroyed by the earthquake of 1906 and the meteorite found in the ruins. It was then removed to the Museum of the State Mining Bureau.

The shape and dimensions of this mass as given by Whitney [14] were as follows:

Shape irregular, but in general that of a flattened elongated slab; length, 49 inches; average breadth, 18 inches; thickness varying from 2 to 5 inches. Weight, 632 pounds.

The dimensions of the ring-shaped mass were given by Whitney [14] as follows:

Greatest exterior diameter	49	inches
Least exterior diameter	38	inches
Greatest width of central opening	26.5	inches
Least width of central opening	23	inches
Greatest thickness at right angles to plane of ring	10	inches
Width of thickest part of ring	17.5	inches
Width of narrowest part	2.75	inches
Weight estimated by Ainsa as	1,600	pounds
An inscription on the specimen now gives the weight as	1,400	pounds

Whitney [14] indicated the Sierra de la Santa Catarina as the locality of the Tucson-Iron and left it undetermined whether this was the same mountain range which Velasco had called the Sierra de la Madera.

The statements regarding Tucson, made at different times by Meunier [17, 24] have very little agreement one with another. In 1869 [17] he gave the specific gravity of the olivine as 3.35 and classed the iron among those which yield distinct Widmannstätten figures; in 1873 [19] he pronounced Tucson a mixture of tænite and nickel-free iron; in 1884 [20] he repeated the statement with regard to the action of etching, in one place, while in another place he declares that no figures are produced by the acid; in 1893 [24] he stated that Tucson consists of a distinct alloy of nickel-iron, Tucsonine, with more than 10 per cent of nickel; the structure he said was octahedral, but the iron yielded no figures with acid.

In 1870 Haidinger [18] assumed a vein-origin formation for the Carleton-Tucson meteorite. For the ring-shaped Ainsa-Tucson he assumed the perforation of a flat iron mass rotating in the direction of its greatest breadth by the action of atmospheric resistance. Through stability of rotation, he thought a ring would form; if this continued longer a disruption would occur and fragments somewhat of the form of Hraschina would result.

Wadsworth [21] included Tucson among the pallasites. According to him the silicates are arranged in the ring-shaped mass approximately in regular rows, whereby a certain similarity

to fluid structure arises. Small grains isolated by means of a needle appeared for the most part as olivine with inclusions of gas bubbles. A few small fragments, he stated, behaved like feldspar, sometimes with, sometimes without twin striping.

Brezina [22] distinguished three irons in 1885—Cañada de Hiero, Carleton-Tucson and Tucson-Ainsa. The first, on account of observed hexahedral cleavage, was included with the hexahedrites; the two latter were, on the contrary, placed in different divisions of the ataxites, "since they indeed showed a certain similarity, but not sufficient, without further investigation, to class them together." In the case of Carleton-Tucson, however, it was pointed out that it showed large flakes separated by fine, crumpled veins of schreibersite.

In 1890 Fletcher [23] collected all former investigations of importance, instituted a critical examination of the credibility of the data concerning the place of discovery, and compared the structure of the two masses. He came to the following conclusions:

The true locality is the Puerto de los Muchachos, lying between Tucson and Tubac in the Sierra de la Madera. Both masses originated from the same locality, belonged to one and the same fall and, according to authentic specimens in the British Museum, agree in all essential characteristics. The silicate grains are of the same dimensions in both (for the most part 0.1 to 0.2, occasionally 1 mm. in size) and of the same appearance; they are mostly roundish and irregularly distributed, although in certain places they are elongated in form and arranged in parallel, somewhat bent rows; etching produces no Widmannstätten figures, but an irregular network of yellow lines resembling tænite or schreibersite, and each inclusion is bordered in the same way. It is not certain to which mass the analyses of Shepard, Genth, and Smith belong. From the two latter, along with that of Brush, I estimated the following composition for the nickel-iron and olivine:

Nickel-iron.					Olivine.							
Fe	Ni	Co	Cu		FeO	MgB	CaO	Al_2O_3	Na_2O	K_2O	SiO_2	
89.89	9.58	0.49	0.04	=100	24.07	27.37	8.67	Trace	2.15	1.26	36.43	=99.95

From the above analyses I derived the following mineralogical composition:

	Smith.	Genth.	Brush.
Nickel-iron	90.64	90.03	86.24
Olivine	8.29	8.60	10.05
Schreibersite	0.77	0.64	3.18
Chromite	0.30	0.73	0.53
	100.00	100.00	100.00

Fletcher [23] classed this iron among the siderolites, which form the connecting link between the meteoric irons and the meteoric stones, and included it, like Wadsworth, with the pallasites.

In 1895 Brezina,[26] upon the ground of Fletcher's investigation, united the two Tucson blocks under the name "Muchachos" and formed of them the Tucson group, a subdivision of the ataxites, for which the characteristic is "iron fragments separated by schreibersite veins." The individual grains with their half-shaded markings were said to contain oriented rhabdite lamellæ, so that Brezina remarked that the iron might be reckoned as a brecciated Chesterville iron. In regard to Cañada de Hiero it was merely stated in the table of contents that it resembled Muchachos; also an iron obtained from Jackson with the label "La Concepcion in Chihuahua" was identified with Muchachos.

Cohen [25, 28, 29] made a careful study of specimens from the two irons with results as follows:

The polished surfaces, with the exception of the stony inclusions, make an entirely homogeneous impression. After weak etching, however, the nickel-iron appears as irregular masses which are distinctly separated from one another by very fine, glistening, zigzag seams. In Carleton they are somewhat broader and on that account show more distinctly than in Ainsa; in the former iron almost all the silicate grains too are surrounded by similar seams averaging 0.01 mm. in width, while this is the case with only a few of the Ainsa grains. These seams may be characterized as tænitic or schreibersitic; Rose calls them simply tænite, and Brezina schreibersite. By experiment with a fine needle under the microscope they appear to be ductile, so that it is apparently tænite or an alloy richer in nickel than the ordinary nickel iron, but not so rich in nickel and consequently not so resistant to HCl as normal tænite. At all events upon treating portions of both irons with dilute HCl or copper ammonium chloride no scales or lamellæ remain undissolved, though it is to be observed that tænite as well as schreibersite in very fine fragments can be dissolved in considerable quantity.

The above-mentioned grains of nickel-iron are of varying size; in the pieces which I examined they fall between 0.2 and 2 cm. Each grain has its own luster, so that one part of the etched surface in a certain light appears light gray and glistening and another part dark gray and dull. Under the microscope the nickel-iron within the composition pieces has a speckled appearance, but the patches overlap so as to completely obliterate the outlines, and there is no

indication of a structure composed of distinct grains. All that is observable is numerous, tiny, closely compacted, brightly glistening points apparently produced by the reflection of light from the walls of inequalities produced by etching. They are in general uniformly distributed; in some of the composing pieces they arrange themselves in such a way as to produce a sort of interlaced striping whose direction varies in each grain. Rhabdite, which according to Brezina is present in oriented form, I did not find, nor troilite nor schreibersite.

In thin sections the silicate inclusions appear to be chiefly olivine. As also stated by Wadsworth, they are accompanied by plagioclase, which may be easily distinguished from the olivine by the double refraction and twinning striæ. In one grain the olivine is present only in the central portion and sharply contrasts with a single small bordering zone. Such a zonal formation is seldom observed in the case of meteoric material. According to estimate from five thin sections, plagioclase occurs in such minute quantities that it could not influence the results of analysis in any noticeable degree. Most of the olivine grains consist of a single individual, occasionally spherical in form, in other cases roundish or oval (when as a rule they are twice as long as wide) and measure 0.05 to 0.20 mm. in size. However, they fall sometimes as low as 0. 01 mm. and again occur as large as 1 mm. In the case of the larger sizes they are without exception aggregates of several grains, and the resulting form is usually elongated. Isolated grains were observed which consisted of two straight and well-defined individuals, such as to suggest twinning. Moreover, such grains occur very rarely on which are to be seen indications of crystal outlines. The distribution is in general quite uniform and regular; in the case of Carleton, however, the olivines arrange themselves in some portions of the section quite plainly in bent, nearly parallel-line systems, which converge to several centers and are entirely independent of the direction of the boundaries of the nickel-iron grains. Upon the much smaller Ainsa iron specimen this appearance was not observed. In this case also the roundish forms prevail to a greater extent, and the grains are on the average somewhat smaller, although the number is somewhat greater, so that the total amount of olivine in both irons is approximately the same.

In thin sections the olivine appears quite colorless. Undulatory extinction which is so common in the stone meteorites was not observed . Many grains are free from inclusions, others contain small, spherical to roundish opaque granules (apparently of nickel iron), or colorless inclusions with one or more vesicles apparently of glass. Cracks are noticeably scarce. They are as a rule entirely wanting on the olivines of small to medium dimensions. In the larger grains and aggregations whose number is comparatively small, they are usually quite abundant and run very irregularly. A coating of iron hydroxide is quite common; it is due apparently to the thin section, since it was not observed in isolated grains.

Although in the specimens examined, individual differences between Carleton and Ainsa are observable, it is to be noted that these are very meager, and only to be discovered by very careful comparison, so that they would not serve to distinguish with certainty between specimens from the two localities.

For the purpose of ascertaining their chemical composition, a larger piece of each iron was treated with cold dilute HCl, in order to separate the olivine from the nickel iron and obtain a sufficient quantity of the former for an analysis. The isolated grains were colorless and sometimes clear as water, sometimes somewhat cloudy, apparently because of the incipient action of the acid. As many grains were grown together with or penetrated by nickel iron, all of this was removed that could be separated by means of a magnetic knife. But not all grains with opaque inclusions could be removed without reducing too much the quantity of material. The heavy portion removed by the magnet or separated from the olivine by means of methyl iodide, was treated with HCl, and a residuum composed mostly of silicic acid was left; this solution was combined with the principal solution. The proportions were as follows:

	Carleton	Ainsa
Soluble portion	96. 32	96. 61
Residue (SiO_2)	0. 82	0. 67
Olivine	2. 86	2. 72
	100. 00	100. 00

By J. Fahrenhorst's analysis the following results were obtained (*a* indicating the totals; *b* the nickel-iron portion). The results obtained for chlorine and carbon in Carleton are inserted in Ainsa.

	Carleton		Ainsa	
	a	b	a	b
Fe	84. 56	89. 32	84. 60	89. 40
Ni	8. 89	9. 18	9. 24	9. 54
Co	1. 36	1. 41	. 95	. 98
Cu	. 03	. 03	. 02	. 02
Cr	. 02	. 02	. 02	. 02
C	. 04	. 04	. 04	. 04
S	trace		. 01	
Cl	. 04		. 04	
P	. 16		. 17	
SiO_2	1. 72		1. 76	
MgO	. 59		. 51	
CaO	trace		.....	
Olivine and residue	3. 68		3. 39	
	101. 09	100. 00	100. 75	100. 00

Finally, as the composition of the isolated olivine:

SiO_2	45.82	44.91
FeO (by difference)	1.75	2.08
CaO	3.30	1.33
MgO	49.13	51.44
	100.00	99.76

Specific gravity, 3.24 to 3.27 (by methyl iodide).

$SiO_2 : MgO+CaO+FeO$ 1 : 1.719 1 : 1.791

As the olivine, according to the result of the microscopical examination and according to the proportion of RO : SiO_2 in the case of the isolation with HCl, was not altogether unchanged, a further portion of the Carleton iron was treated with copper ammonium chloride, which, in accordance with previous experiments did not noticeably affect the olivine, although a small portion was dissolved. The isolated grains appeared under the microscope colorless, transparent, and entirely unaltered. They gave the following composition:

SiO_2	43.29
FeO	.52
CaO	1.13
MgO	54.92
	99.86

Specific gravity, 3.199.

SiO : FeO+CaO+MgO 1 : 1.95

It is thus certain that we have here a forsterite with a small mixture of monticellite. The small amount of iron would not change this conclusion even if it could not, as is possible, be referred mainly or entirely to inclusions. The alkalies could not, for lack of material, be determined; but since plagioclase was observed only very sparingly in the thin sections, it can not compose more than a fraction of 1 per cent of the silicate at most. The entire or almost entire absence of iron oxide in the olivine, although iron was present in so considerable quantity, is explained by the fact that the oxygen present only sufficed to oxidize the magnesia and silica, which have a greater affinity for oxygen than iron, nickel, and cobalt.

The composition of the nickel iron is in both masses so near alike that the percentage of nickel and cobalt does not differ materially (10.59 per cent and 10.52 per cent); the proportion of the two elements is, however, very different (Co 1.41 and 0.98 per cent), and the difference is so great that it can not be ascribed to a mistake in the analysis.

The great excess of silica in both total analyses is inexplicable. It is also found in the analyses by Smith, Brush, and Genth and was the occasion of Fletcher's reckoning from the latter an olivine with about 24 per cent iron oxide. In this direction a still further investigation is desirable.

If this excess of silica be disregarded and the small amount of iron in the olivine which is apparently due to inclusions of nickel iron be overlooked, the following composition may be given for Carleton. For Ainsa, were the necessary data at hand, almost the same figures would suffice.

				Nickel iron
94.07 Nickel iron	Fe	84.02	84.63	89.32
	Ni	8.63	8.89	9.18
	Co	1.33	1.37	1.41
	Cu	.03	.03	.03
	Cr	.02	.02	.02
	C	.04	.04	.04
				100.00
1.04 Schreibersite	Fe	.58		
	Ni	.26		
	Co	.04		
	P	.16		
0.07 Lawrenceite	Fe	.03		
	Cl	.04		
4.82 Olivine	SiO_2	2.10	2.10	43.58
	CaO	.06	.06	1.14
	MgO	2.66	2.66	55.28
100.00		100.00	100.00	100.00

The specific gravity was determined by Leick (at 19.8 C.) as 7.2248; disregarding the accessory material, that for the nickel iron was as 7.7357. Carleton takes on a strong permanent magnetism and has a quite strong coercion force.

As already stated, the ring-shaped (Ainsa) mass is in the United States National Museum; the kidney-shaped (Carleton) mass in the California State Mining Bureau, San Francisco. Small sections are to be found in several collections.

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Tulisca. See Tomatlan.

Turner Mound. See Anderson.

UNION COUNTY.

Georgia.
Latitude 34° 49′ N., longitude 84° 12′ W.
Iron. Coarsest octahedrite (Ogg) of Brezina; Nelsonite (type 5) of Meunier.
Found 1853; described 1854.
Weight, 6.8 kgs. (15 lbs.).

This meteorite was first described by Shepard,[1] who states that a piece weighing 1 pound 1.75 ounces was brought him from a mass said to weigh about 15 pounds, found in Union County, Georgia. Shepard further describes his specimen as follows:

It appears to have formed a portion of a somewhat tabular mass about 2 inches in thickness. It is coated on three sides with a thin scaly covering of brownish-black hydrated peroxide of iron. The other two sides present the appearance of a fresh fracture but are, nevertheless, destitute of metallic luster, the surfaces being very irregular and dependent in form upon the peculiar concretionary character of the mass, which is strongly analogous to that of a very coarse-

grained colophonite garnet, or the coccolite variety of pyroxene. It is, however, more or less traversed by cylindrical or almond-shaped masses of meteoric pyrites, some of which are above an inch in length and one-third of an inch in diameter.

When polished it approaches more nearly to a silver-white color than any other meteoric iron. When acted upon by acids it does not give the Widmannstätten figures, but only develops a series of weblike meshes, or, at most, a mottled, maplike delineation.

Its specific gravity =7.07. A fragment, as nearly as possible free from pyrites, was found to contain 3.32 per cent of nickel. It is rich in chromium, and contains traces of phosphorus, cobalt, magnesium, and calcium.

Brezina [3] in his 1885 catalogue grouped Union County with Nelson County as a breccialike octahedral iron (Obn). He remarks that Tschermak considered them brecciated hexahedrites but that such a classification is incorrect because Nelson County at least shows evident meshes inclosed by tænite. He therefore classed them as coarsest octahedrites of the Seelasgen group, having a brecciated appearance on account of the very changeable width of the bands. In 1895 [5] he abolished the subgroup, however, and classed both Nelson County and Union County simply as coarsest octahedrites (Ogg).

Meunier [4] classed Union County as nelsonite and gave the following as the elementary composition, presumably as the result of analysis:

Fe	Ni	Co		
92.4	6.9	trace	=99.3	Specific gravity, 7.21

Little of the meteorite appears to be extant but more must have been obtained than the 1 pound 1.75 ounces described by Shepard, as the Amherst collection possesses 2 pounds 8 ounces. Wülfing lists 711 grams, of which the Washington Shepard collection possesses 124 grams.

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Utah. See Salt Lake City.

UTE PASS.

Ute Pass, Summit County, Colorado.
Here also Mount Ouray.
Latitude 39° 48′ N., longitude 106° 10′ W.
Iron. Broadest octahedrite (Ogg) of Brezina.
Found, 1894; undescribed.
Weight, ?

The only mention of this meteorite seems to be by Ward [1] who gives the information above.

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VERNON COUNTY.

Vernon County, Wisconsin.
Here also The Claywater Meteorite.
Latitude 43° 30′ N., longitude 91° 10′ W.
Stone. Veined crystalline chondrite (Cka). of Brezina; Erxlebenite (type 34) of Meunier.
Fell 9 a. m. March 25, 1865; described 1876.
Weight. One piece of 700 grams, another of 800 grams.

This meteorite was described by Smith [1] as follows:

The Wisconsin meteorite which fell on March 25, 1865, and is one of much interest, attracted no attention at the time of its fall outside of the immediate neighborhood where it was observed, a fact due to the comparatively sparsely

inhabited nature of the country. It was brought to my attention only a few months ago by one living in a region not far from where it fell. He sent me a small fragment which had been presented to him, and so identical was it in its appearance to the Meno meteorite that fell in 1861, that, not having heard of any fall at the period when this was said to have been found, I considered it at first a fragment of that rare meteorite which had found its way to that part of the country. But on further inquiry and search I was soon satisfied that it was a piece of an undescribed meteorite; I have designated it as the Claywater meteorite. The following is the account I have been able to gather in relation to its fall:

In Vernon County, State of Wisconsin, about latitude 43° 30′ N., longitude 91° 10′ W., at 9 on the morning of March 25, 1865, a body was seen by several persons passing rapidly through the atmosphere, accompanied with a loud rumbling noise. It was luminous and showed flashes of light. Its course was from northwest to southeast, and it exploded at a supposed altitude of 4 miles. At the time that the small fragments were thrown off from the main body a noise like the rolling of musketry was heard. The main body seemed to have a rotary motion, making about one revolution in two seconds of time.

The observer from whom the above facts were obtained thinks that the main body did not fall but passed into space.

No fragments were found until about 5 days after the fall, when two were discovered weighing 1,500 grams. The curves of the surfaces of these fragments would indicate that they pertained to a mass having a diameter of about 30 cm. No data were obtained from which to calculate its velocity, but the observer already referred to says that it was variously estimated at from 15 to 25 miles per second. Of the two fragments that fell one has been lost or destroyed, the other has been placed in my possession by Mr. Claywater, who made the observations already recorded and to whom we are indebted for the preservation of what we have of this interesting meteorite, for it differs in its physical aspects from any yet observed in this country. The fragment in my possession and which is all that has been recovered from this fall weighed 700 grams; about one-third of the surface was covered with a thick dull black crust; the fractured surfaces are quite granular, and its structure porous; it belongs to the hard variety of meteoric stones. Examined with a glass the grains are of a dirty-green color with a greasy aspect, and in some places have a globular structure. Particles of iron are disseminated abundantly through the mass, and particles of troilite are also visible. Its specific gravity is 3.66 and it is composed of—

Stony matter	78.33
Metallic particles	17.07
Troilite	4.60
	100.00

The stony matter treated with aqua-regia furnished—

Soluble matter	47.20
Insoluble matter	52.80
	100.00

The composition of these two portions are:

	Soluble	Insoluble
Silica	32.55	57.41
Protoxide of iron	30.40	9.50
Alumina	trace	4.00
Magnesia	35.80	22.80
Lime	.....	3.70
Soda	.60	2.01
	99.35	99.42

The metallic particles, completely separated from the stony portion are composed of—

Iron	92.15
Nickel	7.37
Cobalt	.28
Copper	.....
	99.80

Phosphorus (minute, not estimated).

In regarding the above analysis it is very evident that the meteorite is—

Bronzite, with probably a little anorthite	41.35
Hyalosiderite (olivine)	36.98
Nickeliferous iron	17.07
Troilite	4.60

By Brezina [2] the meteorite was classified in 1885 as a crystalline chondrite, and in 1895 as a veined crystalline chondrite with Pipe Creek. No further study of the meteorite seems to have been made.

It is distributed, the Harvard University collection having the largest amount—200 grams.

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Victoria. See Iron Creek.

WACONDA.

Mitchell County, Kansas.
Latitude 39° 28′ N., longitude 98° 30′ W.
Stone. Brecciated crystalline chondrite (Ccb) of Brezina; Aumalite (type 37) of Meunier.
Found 1874; described 1876.
Weight, 45 kgs. (90 lbs.).

This stone is described by Shepard [1] as having been found in 1870, lying above ground in the grass, upon the slope of a ravine, at the distance of 2 miles from the village of Waconda, Mitchell County, Kansas. He goes on to say:

Many pieces were then broken off from the mass, leaving about one-half, whose present weight is 58 pounds, half of which is still covered by the original crust. The freshness of the specimens was equal to that of any newly fallen stone, indicating a recent fall.

Its cohesion is about that of the average among meteoric stones. In this respect, as well as shade of color, it corresponds very nearly to the Searsport, Maine, stone of May 21, 1871; but in structure it differs in being less oolitic. Indeed, it is only obscurely so at all, the individuals that are distinct being rather granular, often with well-marked angles, some of which suggest the species augite; others, those of forsterite (variety boltonite). There is considerable amorphous whitish matter interposed among the grains (in which they may be said to be embedded), which is doubtless a mixture of minerals, and may consist of chladnite with some one or more of the feldspars. The chamasite (nickelic iron) is present in thickly scattered, very minute, rounded, lustrous grains, requiring for the most part the use of a lens for their discovery; while the troilite (magnetic pyrites) is now and then seen in considerable grains, or ovoidal aggregations of imperfect crystals. The crust is rather thicker than usual, of a dull iron-black color, with a slight tinge of brown, and much crumpled or reticulated. The specific gravity of a fragment weighing 4.35 grams (of which two-fifths were covered by crust) is 3.810; that of a fragment without crust, weighing 3.57 grams, is 3.58.

By mechanical analysis the stone gave 5.66 per cent of chamasite and 1.34 per cent of troilite. The earthy portion was rather more than one-half decomposed by aqua regia, the soluble portion, after the separation of the silica, giving magnesia and protoxide of iron (with a little lime) in the usual proportions of chrysolite. The matter not attacked by acids probably belongs to augite, some feldspathic species, and chladnite.

There exists a rumor that a second stone has been found 12 miles distant from the first, but it lacks confirmation.

Smith [2] gave the following account of this meteorite:

The meteorites under consideration have been known for some little time, Prof. C. U. Shepard having given a notice of the Waconda meteoric stone in the American Journal of June, 1876, he having acquired the larger portion of it; the remainder has been kindly presented to me by G. W. Chapman. One feature to be noticed in connection with this meteoric stone is that the time of its fall is not known, it having been discovered in a ravine near the village of Waconda, in Kansas (latitude 39° 20′ N., longitude 98° 10′ W.). While there are three or four of these softer meteoric stones, consisting almost exclusively of stony matter, the exact time of whose fall is not known, there is every reason to suppose that their falls were observed and that they were collected at the time; but falling in remote places, and on lands of those not accustomed to note precisely the dates of natural phenomena, the exact date of the fall was forgotten when it reached those who were interested in these bodies. In the present instance nothing was known to lead to its discovery, and it was simply gathered up by an inhabitant of a sparsely settled region and laid aside on account of its singular appearance, and was only recognized as a meteorite some time afterwards by one who had some knowledge of these bodies. Although but recently brought to notice, it was discovered two years ago, and I am inclined to believe that its discovery must have been made not very many months after its fall, as otherwise it would have undergone more thorough decomposition; as it is, the interior is marked with large blotches of oxide of iron arising from oxidation of the particles of iron by the water penetrating from without. This exposure has doubtless had something to do with its friability as a whole, for many parts of it are quite firm where the iron is not oxidized, and, as Professor Shepard says, it has the average cohesion of this class of meteoric stones. As he has already given a general description of it, I will not repeat it here, but proceed at once to give my chemical and mineral analyses. The specific gravity of pieces from the interior varied from 3.4 to 3.6, and when separated mechanically consisted of—

Stony matter	90.81
Nickel-iron	5.34
Troilite	3.85

The amount of the last mineral was made out by chemical analysis. The nickel iron contains—

Fe	Ni	Co	Cu	P	
86.18	12.02	0.91	0.04	trace	=99.15

The stony part treated with large excess of aqua regia gave a soluble part of 69 per cent, insoluble 41 per cent, composed as follows:

	Soluble	Insoluble
Silica	34.52	54.02
Protoxide of iron	30.01	18.10
Magnesia	32.50	23.45
Alumina	0.43	2.30
Manganese	.61	.36
Soda (trace of potash and lithia)	.89	1.58
Lime	....	trace
	98.96	99.81

The analysis clearly shows that the stony part of this meteorite consists of the usual mixture of olivine and pyroxene minerals, the hyalosiderite predominating in the former and bronzite in the latter.

Two minerals were detached in small quantities and analyzed separately. The first was a dark-colored mineral, readily seen in small parcels and veins; this freed as far as possible from the adhering minerals was found to be soluble in strong hydrochloric acid, and the prolonged action of this acid on the mineral, heated over the water bath, decomposed it very nearly completely. It is composed as follows:

Silica	41.10
Protoxide or iron	27.20
Magnesia	28.31
Alumina	.89
Manganese	.32
Soda	1.35

Its solubility in hydrochloric acid and its composition clearly point it out to be of the olivine type.

The other mineral was found only on one part of my specimens, and there in the form of a white crystalline mass not exceeding in weight 20 milligrams. It looked at first sight like enstatite, but there was sufficient difference in its aspect to lead me to detach a few milligrams and test it, when I found it readily and completely soluble in hydrochloric acid, and as far as it was possible to decide on so minute a quantity it appeared to consist only of silica and magnesia. Its solubility shows clearly that it is not enstatite, and I can only imagine it to be of the olivine type and consisting entirely of silica and magnesia, occupying the same place among the unisilicates of the meteorites that the enstatite does among the bisilicates. I simply note this fact here, not as giving any very definite results, but simply that it may be looked into by those investigating these subjects.

Wadsworth [3] gave a description as follows:

The specimens purchased for the Whitney collection from Ward and Howell show an ash-gray groundmass stained with brownish spots of rust, and containing grains of grayish-brown olivine.

The section shows a yellowish-brown and grayish groundmass containing iron. On one side a black band forming the exterior (rind) of the meteorite is preserved. The groundmass is composed of olivine grains with some enstatite. The yellowish-brown color is owing to a ferruginous staining of the silicates, while the rind is composed of the same minerals as the interior, but owing to the heat to which it has been exposed it has been burned black. Clear grains of untouched silicates (olivine and enstatite) are to be seen both in the interior and in the crust.

In one corner of the section a small amount of fine ash-gray semibase was observed cementing olivine grains.

The mixed enstatite and augite with iron and a ferruginous-stained groundmass are shown in a plate.

Brezina [5] classified the meteorite as a brecciated crystalline chondrite, and described it as follows:

It is a stone of rather uneven structure, which outwardly is obscured by the somewhat extensive rusting of most of the pieces. A still fairly fresh fragment of the Vienna collection shows the chondritic character. The principal piece, of some 4 kg., shows this characteristic only indistinctly, on account of the progress of the rusting, while on the contrary the brecciated character is here very distinctly shown. Dark blue-gray particles alternate extensively with white, quite like Weston. Occas onally these two sorts of particles border upon one another in large and quite level faces. Nodules consisting of a mixture of troilite and nickel iron attain a size of 1 to 2 cm. In one place a nodule of 50 grams weight with hardened groundmass was found which contained many chondri broken in two and was covered with a thick bark-like crust.

The 58-pound mass described by Shepard is in the Amherst collection. From other sources about 30 pounds must have been obtained, as Wülfing [6] lists 15,786 grams distributed.

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Waldo County. See Searsmont.

Waldron Ridge. See Wallens Ridge.

WALKER COUNTY.

Alabama.
Here also Alabama 1843, Claiborne and Lime Creek, in part, and Morgan County.
Latitude 33° 50′ N., longitude 87° 15′ W.
Iron. Hexahedrite (H) of Brezina.
Found, 1832.
Weight, 75 kgs. (165 lbs.).

The history and characters of this meteorite have been summarized by Cohen [22] as follows:

According to Troost,[1] an iron mass of 75-kg. weight was found in 1832 in the northeast corner of Walker County by a hunter living in Morgan County, who preserved it in his house until 1843; in this year the mass came into the possession of Troost. It was of an irregular oval form, with a smooth exterior covered with a thick coating of rust and afforded a compact, crystalline fracture with noticeable triangular folia. Upon the etched surface appeared lines which formed equilateral triangles, except where elongated at the section surface. Upon cutting into the iron a nodule 6½ cm. in size and easily loosened from its matrix was found. It had a thin, glistening, white metallic zone surrounding it (probably troilite with a schreibersite border). The exterior sweat iron chloride, while the interior was free from chlorine.

The data from Shepard [2] are set aside by the above observations.

According to Reichenbach [3, 7], the nearly half spherical piece covered with a coating of rust about 1½ cm. thick contained in his collection was very similar to that of Braunau. It showed no Widmannstätten figures, and consisted almost exclusively of kamacite, which showed no indication of granular structure, but formed a crystalline individual containing, however, delicate patches of plessite bordered with tænite and rich in needles (taken at that time for tænite!); "In the most delicate manner a spray of the finest parallel straight lines runs through the whole, exactly like those of Hauptmannsdorf, penetrating the entire mass of iron and crossed at acute angles by other straight lines also parallel to one another." In addition to the needles, Reichenbach described other accessory constituents: Bronze-colored iron sulphide in roundish nodules as much as 2.5 cm. in size, "Kiesflecke," small particles of graphite, schreibersite alone and grown together with iron sulphide, numerous larger and smaller flakes and granules scattered through the kamacite without any order and parallel banded isinglass on the edges of the mass. Reichenbach emphasized the absence of swathing kamacite and the fact that Walker County belongs to the least complex meteoric irons. The occurrence of chlorine is mentioned in a way which creates the impression that he did not observe it himself. Reichenbach was evidently convinced that his material was a portion of the Claiborne (Lime Creek) iron described by Jackson, since he cited the analyses of Hayes. Because of the high percentage of nickel given by the latter, he at first compared his piece with Babbs Mill and Cape of Good Hope.

Rose [12] also compared the Reichenbach section with the Braunau iron; it showed, he said, besides etching lines and cross sections of rhabdite a few large gray concretions of a metallic luster in the form of grains and needles. According to Huntington,[14] Walker County shows "octahedral cleavage" and "figures" which fall between those of Butler and Coahuila, although comparing more nearly with the latter. It is, however, coarser and shows more distinctly "Tschermak's Trias."

So far as Meunier's [15] brief mention indicates, it would appear that Walker County is not represented in Paris.

The following description is based principally upon an end piece from the Tübingen collection, weighing 1,740 grams, and having a section surface of 100 sq. cm.

The exterior is composed of a coating of rust of considerable thickness, but from the state of preservation of the evenly and thickly distributed shallow saucer-like depressions no material alteration of form due to weathering has taken place.

After weak etching the Neumann lines come out distinctly, of which a few systems by their length (occasionally as as much as 3 cm.) and depth are quite sharply distinguished from the others, although they are only distinctly visible under the microscope. The distribution is very irregular. In a few places they lie closely compacted together, fre-

quently intersecting one another; usually, however, they occur more sparingly and so widely separated that they but seldom intersect. A sharp contrast between the lines is often observed also. Between the etching lines and in the larger spaces free from the latter the nickel iron is unusually rich in closely and regularly distributed pittings. Although these appear to be all of the same character, I consider it possible, judging from the conspicuous abundance of rhabdite in a solution, and the comparatively small number of visible needles of this substance, that they are not exclusively etch-pittings, but that rhabdite, slightly etched and oriented perpendicular to the section surface, contributes to the formation of these depressions. In the immediate vicinity of larger and deeper etching lines, as well as of larger rhabdites and even at a somewhat greater distance from the schreibersite, the pittings are wanting as a rule, so as to produce a smooth and shiny etching zone—of a maximum breadth of about a millimeter—in which by the aid of a powerful glass still finer etching lines can be discerned, and which show the same oriented luster as the principal mass of the nickel iron. Upon this zone is found by the side of the schreibersite an area of nickel iron which, in sharp contrast to the bright and uniform oriented sheen of the principal mass, appears dull gray and of a dull luster. Where the schreibersite lies isolated and widely separated the two areas—of which the outer is twice as wide as the inner—follow the outline of the schreibersite. Where the schreibersites are nearer together the dull zones become united and form extended and very irregular but sharply-defined dull patches, which give the etching surface a very peculiar appearance. But as large portions of the nickel iron do not have this character, it may be wanting on small specimens of the Walker County iron. These dull gray patches give the impression of fine-grained nickel iron; but as finer etching lines may be discerned within these areas I consider it probable that densely crowded and deepened etch pittings are the cause of the varying appearance of such portions of the etching surface. The rhabdites, mostly 1 mm. long, often shorter, in isolated instances reaching a length of 8 mm. and arranged in two directions perpendicular to each other, are so fine that they can only be distinguished from etching lines by the aid of a high-power microscope. In a certain light they appear, however, as very fine, brightly gleaming streaks. The distribution is so irregular that spaces of 4 sq. cm. in size are entirely free from them, while they are much crowded in some places. Nickel-iron phosphide occurs also in the form of schreibersite, irregularly distributed; it consists of elongated crystals as much as 1 cm. in size with uneven surfaces, which after polishing appear hollowed out under the protection of a small compact border zone. Whether the crystals possess a porous center or are compacted together with troilite and daubréelite at the central part, which crumbles out by polishing, can not be determined. Troilite in distinctly recognizable inclusions is not to be found on the 100 sq. cm. section surface; however, there occur here a few fine lamellæ easily mistakable for etching lines and having a different orientation from that of the rhabdite, which I regard as Reichenbach lamellæ, which were also mentioned by Reichenbach [10] on the London specimen ("scales as thin as parchment and 4 cm. long"). Troilite has been observed on other specimens, however, and an isolated portion proved to be an excellent conductor of electricity.[21] In general, nevertheless, accessory material occurs very sparingly in the Walker County iron, as Reichenbach has already shown.

Walker County takes on a strong permanent magnetism; Leick determined the specific magnetism to be 0.58 absolute units per gram.

In the course of dissolving a piece of considerable size in much diluted HCl the following observations were made.[16] In the nickel-iron, deep straight rills are gradually formed, apparently because the dissolution proceeded rapidly along the twin lamellæ. The rhabdite is, as a rule, between 0.001 and 0.004 mm. thick, but both dimensions were not infrequently exceeded (observed extremes, 0.0009 and 0.03 mm.). The insoluble residue contained chromite and grains of silica. The former consisted of irregular grains and fragments, besides fine octahedrons and dodecahedrons. Among the silicate grains much the most prominent are colorless ones, with low interference colors and mostly high, but occasionally low, indices of refraction. Next in amount come colorless strongly doubly refracting grains, sometimes with an index of refraction which approaches very closely that of Canada balsam, sometimes with a wider border. Sparingly occur colorless, six-sided plates resembling tridymite with weak anomalous double refraction—bluish, pleochroitic grains with weak double refraction and distinct but not very broad outline—broken grains. Finally, there remained a lamella of schreibersite 10 mm. long, 2 mm. wide, and about 0.25 mm. thick, whose presence was not noticed before treating the plate with HCl.

Analysis (Hildebrand):

Fe	Ni	Co	Cu	Cr	P	S		
94.14	5.30	0.64	0.06	0.05	0.28	0.19	=100.66	Sp. gr., 7.7806.

Composition:

Nickel-iron	97.70
Schreibersite	1.81
Daubréelite	0.14
Troilite	0.35
	100.00

Walker County has been much confused with Limestone Creek, also with a pseudometeorite. The history of these errors is given by Cohen,[22] as follows:

According to a brief communication from Fletcher, the principal mass (65.75 kgs.) of this iron was offered for sale in 1843, under the name Alabama, by Troost, through the medium of Heuland, to the British Museum, which acquired 22.5 kgs. It may be assumed with certainty that the remainder of the mass came into the possession of Reichenbach, since he states that the other half of his piece was in London (9.119), and since the two pieces together weigh 62.5 kgs.

This corresponds quite well with the weight of the portion brought to Europe, if we consider that Reichenbach gave a portion of his specimen to other collections, for example 157 grams to Berlin. In 1843, only Claiborne (Lime Creek) was known in the literature as coming from Alabama (Troost's work on Walker County first appeared in 1845), and it is easily explained from this fact that both pieces were originally referred to Claiborne and that they were catalogued as such. Although Heuland gave the correct locality as early as 1845, the name was first changed in the catalogue of the British Museum in 1863, while Reichenbach apparently overlooked this fact. Wherever in other collections specimens are found with the label "Claiborne," which were obtained from Reichenbach, they likewise belong to Walker County. This is certainly the case with regard to the 231-gram section, designated as Claiborne, in the Vienna Museum.

The first mention of the locality "Morgan County" is found in Buchner, who adds that he could find no printed notice concerning it. He refers to a 70-gram section in Vienna, which resembles Braunau.[11] Brezina says of this section, that it is a hexahedrite probably found in 1849, which Shepard sent with the remark, "I send the new Morgan County iron (formerly called Walker County)." Brezina adds that "Fletcher assumes that the locality, Morgan County, is to be extended to include our hexahedral specimen designated as Walker County, 1832." [18] (This 65-gram section, very imperfectly etched, also belongs without doubt to the herein described Walker County specimen.) Shepard probably made a mistake from the fact that a hunter living in Morgan County found the Walker County iron and kept it in his house for 11 years.

Finally, there are in many collections pseudometeorites under the name of Walker County or Morgan County. This error may have been extended by Shepard, since he analyzed and described a pseudometeorite instead of the supposed Walker County iron. He found 99.89 per cent iron in this specimen, and regarded Walker County accordingly as proof that nickel-free iron can have a meteoric origin. The specific gravity, as well as the character of the etched surface, as described, indicates a pseudometeorite. Here, for example, belong sections of a mass designated as Walker County in Berlin and Vienna, which, according to Gregory, came from the Smith collection, as well as a "Morgan County" specimen at Tübingen.

It appears, accordingly, that Claiborne (Lime Creek) in the Reichenbach collection, as well as the material donated by him under this name, is in fact Walker County, and that under the name Walker County (Morgan County) hexahedrites and pseudometeorites are to be found in collections. The former originate from the Troost mass, the latter were probably distributed by Shepard, who supposed that the piece examined by him came from Walker County.

The largest pieces of the meteorite as at present distributed are at Tübingen (40 kg.) and London 22.5 kg.

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Walker Township. See Grand Rapids.

WALLENS RIDGE.

Claiborne County, Tennessee.
Here also, Waldron Ridge.
Latitude 36° 30′ N., longitude 83° 30′ W.
Iron. Coarse octahedrite (Og), of Brezina; Arvaite (type 7), of Meunier.
Found and described 1887.
Weight, 8 kgs. (18 lbs.).

This meteorite was first described by Kunz[1] as the Waldron Ridge meteorite. Ledoux[2] stated that the mass was found by a prospector on Waldron Ridge, 10 miles northeast of Cumberland Gap, Tennessee. The United States topographic maps of the region, however, do not give the name of Waldron Ridge. They give Wallens Ridge, about 10 miles southeast of Cumberland Gap. It seems probable to the writer that this was the locality of find of the meteorite and he has therefore changed the name accordingly.

Kunz's[1] account of the meteorite was as follows:

During March, 1887, Judge Fulkerson, of Tazewell, Claiborne County, Tennessee, received from some prospector in the vicinity specimens of what was supposed to be an ore of iron. Some of these were sent to Dr. J. M. Harbison and Prof. W. E. Moses, of Knoxville, Tennessee, to Dr. J. S. Newberry, of the School of Mines, Professor Safford, of the University of Tennessee, and others. Through the kindness of the three former gentlemen specimens have come into my possession. This iron is one of the Caillite group of Meunier. In structure it is one of the octahedral irons. On the largest piece, weighing 15 pounds, this is very marked, as it is scarcely altered. All the other pieces, weighing collectively several pounds, have been detached from around this piece which was apparently the center of the mass. The smaller pieces all show considerable weathering. Several perfect octahedrons and one tetrahedron were obtained by simply breaking the iron off with the fingers, it separating very readily at the cleavage plates between which, in nearly all instances, were thin folia of schreibersite. Troilite was also observed as well as graphite, clearly suggesting that this iron is identical with the Cosby Creek, Cocke County, the Sevier County, the Greenbrier County mass in the British Museum, and the Jennies Creek, Wayne County, West Virginia, meteorites which, although independently described, are evidently parts of one meteorite, as suggested by Huntington, which either exploded on entering our atmosphere so that the fragments traveled according to their impetus, or else threw off these pieces at various periods of its course. In all there was perhaps about 3 pounds, although it was supposed at first that there was a whole mine of it. The other pieces were obtained after the 15-pound piece and not one of them weighed more than a pound.

Ledoux[2] gave the following account:

In this connection I will show another meteorite which I verbally described before this academy in 1887. It is from Waldron Ridge, 10 miles northeast of Cumberland Gap, Tennessee. It weighs 12 pounds and was found by a prospector for iron who sent it to me for analysis in May, 1887. From the same locality, later in the year, a larger piece was also sent me, which by order of the owner, I turned over to Mr. Kunz. It is of the ordinary nickel-iron variety containing:

Fe	93.86
Ni	6.01
	99.87

It undoubtedly belongs to the group of meteorites that have been found—all with similar characteristics—in eastern Tennessee and Virginia, described by Kunz and others.

Meunier[3] classed the meteorite as arvaite and remarked that it possessed all the characters of that type.

Huntington[4] remarked that the Waldron Ridge iron was generally accepted to be identical with that of Cocke County. Later authorities do not, however, agree with this conclusion.

The structure of the meteorite is described by Brezina[5] as follows:

The lamellæ are quite long, straight, in some places hatched and somewhat swollen. The tænite is normally developed. Fields are less abundant than the bands and filled with kamacite-like combs. Upon the polished surfaces ribs of cohenite appear crowded together in some places, in other places large crystals of schreibersite up to 5 cm. long and 8 mm. thick, clustered together in radiating bunches, are seen covered with an envelope of schreibersite of 0.3 mm. in thickness of another color set in swathing kamacite. Outcroppings of troilite and graphite of the size of peas may be seen surrounded by schreibersite and troilite grains.

The iron is distributed, the Vienna Museum having the largest piece (3,873 grams).

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WARRENTON.

Warren County, Missouri.
Latitude 38° 50′ N., longitude 91° 10′ W.
Stone. Ornans type of crystalline chondrite (Cco) of Brezina; Ornansite (type 46) of Meunier.
Fell 7.15 a. m. January 3, 1877.
Weight, about 45 kgs. (100 lbs.).

This meteorite was described almost wholly by Smith [2] as follows:

About sunrise on January 3, 1877, 5 miles from Warrenton in the State of Missouri, latitude 38° 50′ N., longitude 91° 10′ W., a sound was heard by certain observers similar to the whistle of a distant locomotive or, as stated by others, like the passage of a cannon ball through the air. The sound came from the northwest and became louder and louder to four observers near Warrenton. Upon looking up they saw an object falling, which struck a tree, breaking off the limbs and then coming to the ground with a crash. The observers were 50 or 60 meters distant from the spot where it fell. On approaching the place they saw a mass of stone broken into a number of pieces. From the fragments they suppose it to have been originally of a conical form and about 18 inches in length. The snow was melted and the frozen ground thawed near where it fell, but the pieces, although warm, were easily handled. The weight was estimated to have been about 100 pounds; but whether this estimate be correct or not only about 10 or 15 pounds of fragments have been preserved, a good portion of which is in my possession, mostly in small fragments; some specimens are in the cabinet of Yale College and others scattered about among the inhabitants of the country where it fell.

As regards its temperature at the time of falling, I would say that I have a specimen which gives, as it were, a satisfactory record that it was not very hot when it struck the tree, for a portion of the fibers of one of the branches is adhering to the surface, entangled in the rough crust of the stone, and these delicate fibers show not the slightest sign of having been heated. A fact to be noted in connection with the fall of this meteorite is that no explosion was heard, or any luminous phenomena produced by its passage through the air after it was first noticed; this may be in part due to the fact that the fall happened at sunrise; but it was no doubt a meteorite well spent in its rapid motion through the atmosphere and dropped quietly like an exhausted bird in its flight. Its direction, so far as made out, was from northwest to southeast.

Aspect of the stone.—It has its own points of peculiar interest, and is not like any meteorite that I am familiar with, except the Ornans meteorite, which fell July 11, 1868, and this it resembles closely in every particular, as may be seen by comparing my results with those of Pisani (Comptes Rendus Acad. Sci., 1868, vol. 2, p. 663), although his method of recording the analytical results is different from mine, and the specific gravity as made out by him is higher than mine, which is not singular in different specimens of these porous bodies. Its crust is dull black and quite thick; in many places of several centimeters square from 2.5 to 3.5 mm. thick (the thickest I have ever seen), where the crust is a rough scoria that sometimes terminates abruptly on a smooth portion of the crust, and is doubtless produced by the melted matter on the surface being forced backward and opposite to the direction of the flight of the stone, being swept off one portion of the surface, and leaving this part smooth and piled up behind it in the form of a surface scoria.

The interior of the stone has a uniform dark ash color, and is soft and easily crushed; the latter fact accounts for its having broken into fragments as it struck the ground. Its specific gravity is 3.47, and the amount of metallic matter contained in it is small.

Chemical composition.—The stone pulverized and freed from metallic particles gave on analysis an amount of sulphur equal to 3.51 per cent of troilite; the amount of nickeliferous iron was small, being equal to 2.01 per cent. The stony minerals treated with hydrochloric acid gave—

Soluble in acid	80.40
Insoluble in acid	19.60

composed as follows:

	Soluble.	Insoluble.
Silica	33.02	56.90
Iron protoxide	37.57	10.20
Alumina	0.12	0.20
Lime	trace	7.62
Magnesia	28.41	22.41
Soda	0.07	1.00
Nickel oxide	1.54	.....
Cobalt oxide	0.31	.....
Chromium oxide	....	0.33
	101.04	97.66

I obtained chrome oxide 0.33 per cent, indicating 0.50 of chrome iron, if the chrome be present in that form. There is no way, however, by which I can decide this question, although it is probable, since the chrome is in the insoluble part; the oxide of nickel, with the exception of perhaps a minute portion, belongs to the composition of the soluble silicates.

The nickeliferous iron contained in this stone is very small in quantity. This on analysis gave—

Iron	88.51
Nickel	10.21
Cobalt	0.60
	99.32

Mineral constituents of the Warrenton meteorite.—A microscopic examination did not give me any clear indications, for it is not possible to prepare a good section for observation. Its chemical examination, however, shows the usual uni and bisilicates of the olivine and bronzite and pyroxenic types. The most marked feature is the preponderance of the olivine minerals, constituting four-fifths of the mass. The proportion of the mineral constituents is about as follows:

Olivine minerals	76.00
Bronzite and pyroxene minerals	18.00
Nickeliferous iron	2.00
Troilite	3.50
Chrome iron	0.50

Meunier[3] gives two figures illustrating the structure of the meteorite and remarks:

The Warrenton meteorite so much resembles that of Ornans, which fell July 11, 1868, as to indicate that the two were detached from the same mass. It is very friable, which explains its division into fragments at the time of striking the earth.

Brezina,[4] in 1885, classed the meteorite with Ornans as a spherical chondrite and remarked:

The chondri are so numerous that they quite crowd out the groundmass. The two stones (Ornans and Warrenton) are very similar, have a blue-gray color, and a thick dull crust.

In 1895,[5] he gave the date of sunrise on the day of fall of the meteorite (January 3, 1877) as 7.19 a. m.

The distribution of 1,614 grams of the meteorite is listed by Wülfing[6]; the whereabouts of the remainder do not appear.

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6. 1897: Wülfing. Die Meteoriten in Sammlungen, p. 381.

Washington. See Farmington.

Washington County, 1858. See Trenton.

Waterloo. See Seneca Falls.

Wayne County, 1858. See Wooster.

Wayne County, 1883. See Jennies Creek.

WEAVER.

Weaver Mountains, near Wickenburg, Maricopa County, Arizona.
Latitude 33° 58′ N., longitude 112° 35′ W.
Iron. Ataxite, Dba (Klein).
Found 1898.
Weight, 38.8 kgs. (85.5 lbs.).

The first mention of this meteorite seems to have been by Ward,[1] who gives the above data and states that the meteorite is undescribed.

Klein [2] reported the following analysis by Lindner (specific gravity, 7.108):

Fe	Ni	Co	S	P	Insoluble gray residue	
80.78	17.92	0.84	0.15	0.12	0.15	=99.96

The main mass is in the museum of the University of Arizona.

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WELLAND.

Ontario, Canada.
Latitude 43° 0′ N., longitude 79° 15′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1888; described 1890.
Weight, 8 kgs. (17.75 lbs.).

This meteorite was chiefly described by Howell [1] as follows:

This meteorite was found April 30, 1888, about 1.5 miles north of Welland, Ontario, Canada. It was plowed up by Walter Caughell, on land owned by a Mr. Shannon, and attracted attention by its weight, but not being considered valuable it was thrown aside after a small piece weighing 5 ounces had, with much difficulty, been broken off. This piece was kept by Mr. George Holland, brother-in-law of Mr. Shannon, until September last, when he gave it to Dr. McCallum, his family physician, who, being convinced that it was meteoric, forwarded it to me. Mr. Holland was in due time engaged to search for the original mass, which he finally found December 9, 1889, in a pile of old iron inside of an old stove oven.

It is impossible to determine the original size of the mass since it has been so long exposed to oxidation that none of the outer crust or characteristic pittings remain, the general form only being preserved, which is that of a kidney-shaped mass. There has doubtless been considerable reduction in bulk. The two greatest dimensions of the mass are 8 by 6 inches (15 by 20 cm.).

After being freed from all loose scales and including the first piece broken off its total weight was 17.75 pounds.

At several points the octahedral structure is well shown and the decomposition of the iron enabled me to collect the tænite in amount sufficient for analysis, which has been given Mr. J. M. Davison for that purpose. A polished section of the iron treated with dilute acid shows the Widmannstätten figures rather coarse and strong, not unlike the Toluca irons. The entire absence of troilite, as far as can be detected in the various sections, is a marked feature of the iron, the only indication of its presence being the small amount of sulphur shown in the following analysis kindly furnished by Mr. Davison:

Fe	Ni	C	S	
91.17	8.54	0.06	0.07	=99.84

Specific gravity=7.87.

Owing to its freedom from troilite and schreibersite and the separated condition of the plates Davison [2] regarded the iron a good one for analysis of the different nickel-iron alloys. He obtained the following results:

	Kamacite.	Plessite. Kamacite-like part.	Plessite. Tænite-like part.	Tænite.
Fe	93.09	92.81	72.98	74.78
Ni	6.69	6.97	25.87	24.32
Co	.25	.19	.83	.33
C	.02	.19	.91	.50
	100.05	100.16	100.59	99.93

Davison's conclusion from the analysis and structure was that the plessite of Welland was made up of thin alternating lamellæ of kamacite and tænite.

Brezina [3] gives the following observations:

The mass is so much weathered that the three elements of its composition may be mechanically separated. An octahedron 9 cm. in size was weathered out in one place. The bands are long and straight, somewhat grouped and swollen, tænite well developed, meshes filled almost entirely with kamacite-like combs, very rarely with dark-gray plessite. The kamacite and combs are much degranulated and slightly and very finely hatched. Ribs of cohenite are abundant in the kamacite.

The meteorite is distributed. Vienna possesses 1,521 grams.

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1. 1890: HOWELL. Description of new meteorites.—The Welland meteorite. Proc. Rochester Acad. Sci., vol. 1, pp. 86–87 (analysis and illustration).
2. 1891: DAVISON. Analyses of kamacite, tænite, and plessite from the Welland meteoric iron. Amer. Journ. Sci., 3d ser., vol. 42, pp. 64–66.
3. 1895: BREZINA. Wiener Sammlung, p. 284.
4. 1895: COHEN. Meteoreisen-Studien IV. Ann. K. K. Naturhist. Hofmus. Wien, Bd. 10, p. 82, 87.

West Liberty. See Homestead.

WESTON.

Fairfield County, Connecticut.
Latitude 41° 15′ N., longitude 73° 23′ W.
Stone. Brecciated crystalline chondrite (Ccb) of Brezina; Limerickite (type 32) of Meunier.
Fell 6.30 a. m. December 14, 1807; described 1809.
Weight: A shower of stones, the largest weighing about 90 kgs. (200 lbs.). The weights recorded by Silliman and Kingsley give a total of about 135 kgs. (300 lbs.).

The phenomena of this fall were fully described by Professors Silliman and Kingsley, and their account was printed in full or in abstract in several places. The full account which they gave is as follows:[1]

The meteor, which has so recently excited alarm in many and astonishment in all, first made its appearance in Weston, about a quarter or half past 6 o'clock, a. m., on Monday, the 14th inst. [December, 1807]. The morning was somewhat cloudy; the clouds were dispersed in unequal masses, being in some places thick and opaque, in others light, fleecy, and partially transparent; while spots of unclouded sky appeared here and there among them. Along the northern part of the horizon, a space of 10° or 15° was perfectly clear. The day had merely dawned and there was little or no light, except for the moon, which was just setting. Judge Wheeler, to whose intelligence and observation, apparently uninfluenced by fear or imagination we are indebted for the substance of this part of our account, was passing through the inclosure adjoining his house with his face to the north and his eyes on the ground when a sudden flash, occasioned by the transition of a luminous body across the northern margin of the clear sky, illuminated every object and caused him to look up. He immediately discovered a globe of fire just then passing behind the first cloud which was very dark and obscure, although it did not entirely hide the meteor.

In this situation its appearance was distinct and well defined, like that of the sun seen through a mist. It rose from the north and proceeded in a direction nearly perpendicular to the horizon, but inclining by a very small angle to the west and deviating a little from the plane of a great circle but in pretty large curves, sometimes on one side of the plane and sometimes on the other, but never making an angle with it of more than 4° or 5°. It appeared about one-half or two-thirds the diameter of the full moon. This description of its apparent magnitude is vague, but it was impossible to ascertain what angle it subtended. Its progress was not so rapid as that of common meteors and shooting stars. When it passed behind the thinner clouds it appeared brighter than before, and when it passed the spots of clear sky it flashed with a vivid light, yet not so intense as the lightning in a thunderstorm but rather like what is commonly called heat lightning. Its surface was apparently convex.

Where it was not too much obscured by thick clouds, a conical train of paler light was seen to attend it, waving, and in length about 10 or 12 diameters of the body. In the clear sky a brisk scintillation was observed about the body of the meteor, like that of a burning firebrand carried against the wind.

It disappeared about 15° short of the zenith and about the same number of degrees west of the meridian. It did not vanish instantaneously, but grew pretty rapidly fainter and fainter, as a red-hot cannon ball would do, if cooling in the dark, only with much more rapidity.

There was no peculiar smell in the atmosphere, nor were any luminous masses seen to separate from the body. The whole period, between its first appearance and total extinction, was estimated at about 30 seconds.

About 30 or 40 seconds after this, three loud and distinct reports, like those of a 4-pounder near at hand, were heard. They succeeded each other with as much rapidity as was consistent with distinctness, and all together did not occupy 3 seconds. Then followed a rapid succession of reports, less loud and running into each other so as to produce a continued rumbling, like that of a cannon ball rolling over a floor, sometimes louder and at other times fainter; some compared it to the noise of a wagon running rapidly down a long and stony hill; or to a volley of musketry protracted into what is called, in military language, a running fire. This noise continued about as long as the body was in rising, and died away apparently in the direction from which the meteor came.

The accounts of others correspond substantially with this. Time was differently estimated by different people, but the variation was not material. Some augmented the number of loud reports, and terror and imagination seem, in various instances, to have magnified every circumstance of the phenomenon.

The only thing which seemed of any importance, beyond this statement, was derived from Mr. Elihu Staples, who said that when the meteor disappeared, there were apparently three successive efforts or leaps of the fireball, which grew more dim at every throw, and disappeared with the last.

Such were the sensible phenomena which attended this meteor. We purposely avoid describing the appearances which it assumed in other places, leaving this task to others who have the means of performing it more accurately; while we proceed to detail the consequences which followed the explosions and apparent extinction of this luminary.

We allude to the fall of a number of masses of stone in several places, principally within the town of Weston. The places which had been well ascertained at the period of our investigation were six. The most remote were about 9 or 10 miles distant from each other, in a line differing little from the course of the meteor. It is therefore probable that the successive masses fell in this order, the most northerly first, and the most southerly last. We think we are able to point out three principal places where stones have fallen, corresponding with the three loud cannon-like reports, and with the three leaps of the meteor, observed by Mr. Staples. There were some circumstances common to all the cases. There was, in every instance, immediately after the explosions had ceased, a loud whizzing or roaring noise in the air, observed at all the places, and, so far as was ascertained, at the moment of the fall. It excited in some the idea of a tornado; in others, of a large cannon shot in rapid motion; and it filled all with astonishment and apprehension of some impending catastrophe. In every instance immediately after this was heard a sudden and abrupt noise, like that of a ponderous body striking the ground in its fall. Excepting one, the stones were more or less broken. The most important circumstance of the particular cases were as follows:

1. The most northerly fall was within the limits of Huntington, on the border of Weston, about 40 or 50 rods east of the great road from Bridgeport to Newton, in a crossroad, and contiguous to the house of Mr. Merwin Burr. Mr. Burr was standing in the road in front of his house, when the stone fell. The noise produced by its collision with a rock of granite on which it struck, was very loud. Mr. Burr was within 50 feet and immediately searched for the body, but, it being still dark, he did not find it till half an hour after. By the fall some of it was reduced to powder, and the rest of it was broken into very small fragments, which were thrown around to the distance of 20 or 30 feet. The granite rock was stained at the place of contact with a deep lead color. The largest fragment which remained did not exceed the size of a goose egg, and this Mr. Burr found to be still warm in his hand. There was reason to conclude, from all the circumstances, that this stone must have weighed about 20 or 35 pounds.

Mr. Burr has a strong impression that another stone fell in an adjoining field, and it was confidently believed that a large mass had fallen into a neighboring swamp, but neither of these had been found. It is probable that the stone, whose fall has now been described, together with any other masses which may have fallen at the same time, was thrown from the meteor at the first explosion.

2. The masses projected at the second explosion seem to have fallen principally at and in the vicinity of Mr. William Prince's, in Weston, distant about 5 miles, in a southerly direction from Mr. Burr's. Mr. Prince and family were still in bed, when they heard a noise like the fall of a very heavy body, immediately after the explosions. They formed various unsatisfactory conjectures concerning the cause; nor did even a fresh hole made through the turf in the door yard, about 25 feet from the house, lead to any conception of the cause, or induce any other inquiry than why a new post hole should have been dug where there was no use for it. So far were this family from conceiving of the possibility of such an event as stones falling from the clouds. They had, indeed, formed a vague conjecture that the hole might have been made by lightning, but would probably have paid no further attention to the circumstance had they not heard, in the course of the day, that stones had fallen that morning in other parts of the town. This induced them, toward evening, to search the hole in the yard, where they found a stone buried in the loose earth which had fallen in upon it. It was 2 feet from the surface; the hole was about 12 inches in diameter, and as the earth was soft and nearly free from stones, the mass had sustained little injury, only a few fragments having been detached by the shock. The weight of this stone was about 35 pounds. From the descriptions which we have heard, it must have been a noble specimen, and men of science will not cease to deplore that so rare a treasure should have been immediately broken in pieces. All that remained unbroken of this noble mass was a piece of 12 pounds weight, since purchased by Isaac Bronson, Esq., of Greenfield, with the liberal view of presenting it to some public institution.

Six days after, another mass was discovered, half a mile northwest from Mr. Prince's. The search was induced by the confident persuasion of the neighbors that they heard it fall near the spot where it was actually found buried in the earth, weighing from 7 to 10 pounds. It was found by Gideon Hall and Isaac Fairchild. It was in small fragments, having fallen on a globular detached mass of gneiss rock, which it split in two, and which by it was itself shivered in pieces.

The same men informed us that they suspected another stone had fallen in the vicinity, as the report had been distinctly heard, and could be referred to a particular region somewhat to the east. Returning to the place, after an excursion of a few hours to another part of the town, we were gratified to find the conjecture verified by the actual discovery of a mass of 13 pounds weight, which had fallen half a mile to the northeast of Mr. Prince's. Having fallen in a plowed field, without coming into contact with a rock, it was broken only into two principal pieces, one of which, possessing all the characters of the stone in a remarkable degree, we purchased; for it had now become an article of sale. It was urged that it had pleased Heaven to rain down this treasure upon them, and they would bring their thunderbolts to the best market they could. This was, it must be confessed, a wiser mode of managing the business than that which had been adopted by some others at an earlier period of these discoveries. Strongly impressed with the idea that these stones contained gold and silver, they subjected them to all the tortures of ancient

alchemy, and the goldsmith's crucible, the forge, and the blacksmith's anvil, were employed, in vain, to elicit riches which existed only in the imagination.

Two miles southeast from Mr. Prince's, at the foot of Tashowa hill, a fifth mass fell. Its fall was distinctly heard by Mr. Ephraim Porter and his family, who live within 40 rods of the place and in full view. They saw a smoke rise from the spot, as they did also from the hill, where they are positive that another stone struck, as they heard it distinctly. At the time of the fall, having never heard of any such thing, they supposed that lightning had struck the ground, but after three or four days, hearing of the stones which had been found in their vicinity, they were induced to search, and the result was the discovery of a mass of stone in the road, at the place where they supposed the lightning had struck. It penetrated the ground to the depth of 2 feet in the deepest place; the hole was about 20 inches in diameter, and its margin was colored blue from the powder of the stone struck off on its fall.

It was broken into fragments of moderate size, and from the best calculations might have weighed 20 or 25 pounds.

The hole exhibited marks of much violence, the turf being very much torn and thrown about to some distance.

It is probable that the four stones last described were all projected at the second explosion; and, should one be discovered on the neighboring hill, we must, without doubt, refer it to the same avulsion.

3. Last of all, we hasten to what appears to have been the catastrophe of this wonderful phenomenon.

A mass of stone, far exceeding the united weight of all which we have hitherto described, fell in a field belonging to Mr. Elijah Seely and within 30 rods of his house.

A circumstance attended the fall of this which seems to have been peculiar. Mr. Elihu Staples, a man of integrity, lives on the hill at the bottom of which this body fell and witnessed the first appearance, progress, and explosion of the meteor. After the last explosion a rending noise, like that of a whirlwind, passed along to the east of his house and immediately over his orchard, which is on the declivity of the hill. At the same instant a streak of light passed over the orchard in a large curve and seemed to pierce the ground. A shock was felt and a report heard like that of a heavy body falling to the earth, but no conception being entertained of the real cause (for no one in the vicinity with whom we conversed appeared to have ever heard of the fall of stones from the skies) it was supposed that lightning had struck the ground. Three or four hours after the event Mr. Seely went into his field to look after his cattle. He found that some of them had leaped into the adjoining inclosure and all exhibited strong indications of terror. Passing on he was struck with surprise at seeing a spot of ground which he knew to have been recently turfed over all torn up and the earth looking fresh, as if from recent violence. Coming to the place he found a great mass of fragments of a strange-looking stone and immediately called for his wife, who was second on the ground.

Here were exhibited the most striking proofs of violent collision. A ridge of micaceous schist, lying nearly even with the ground and somewhat inclining like the hill to the southeast, was shivered to pieces to a certain extent by the impulses of the stone, which thus received a still more oblique direction, and forced itself into the earth to the depth of 3 feet, tearing a hole of 5 feet in length and 4.5 feet in breadth and throwing large masses of turf and fragments of stone and earth to the distance of 50 and 100 feet. Had there been no meteor, no explosions, and no witnesses of light and shock it would have been impossible for any person contemplating the scene to doubt that a large and heavy body had really fallen from the skies with tremendous momentum.

This stone was all in fragments, none of which exceeded the size of a man's fist, and was rapidly dispersed by numerous visitors, who carried it away at pleasure. Indeed, we found it very difficult to obtain a sufficient supply of specimens of the various stones, an object which was at length accomplished principally by importunity and purchase. From the best information which we could obtain of the quantity of fragments of this last stone, compared with its specific gravity, we concluded that its weight could not have fallen much short of 200 pounds. All the stones when first found were friable, being easily broken between the fingers; this was especially the case where they had been buried in the moist earth, but by exposure to the air they gradually hardened. Such were the circumstances attending the fall of these singular masses. We have named living witnesses; the list of these may be augmented, but we consider the proof as sufficient to satisfy any rational mind. Further confirmation will be derived from the mineralogical description and chemical examination of these stones.

The specimens obtained from all the different places are perfectly similar. The most careless observer would instantly pronounce them portions of a common mass and different from any of the stones commonly seen on this globe.

Of their form nothing very certain can be said, because only comparatively small fragments of the great body of the meteor have been obtained. Few of the specimens weigh 1 pound, most of them less than half a pound and from that to the fraction of an ounce. Mr. Bronson's piece is the largest with which we are acquainted; we possess the next, which weighs 6 pounds and is very perfect in its characteristic marks, and we have a good collection of smaller specimens, many of which are very instructive. They possess every irregular variety of form which might be supposed to arise from accidental fracture with violent force. On many of them, however, and chiefly on the large specimens, may be distinctly perceived portions of the external part of the meteor.

It is everywhere covered with a thin black crust destitute of splendor, and bounded by portions of the large irregular curve which seems to have inclosed the meteoric mass. This curve is far from being uniform. It is sometimes depressed with concavities such as might be produced by pressing a soft and yielding substance. The surface of the crust feels harsh like the prepared fishskin, or shagreen. It gives sparks with the steel. There are certain portions of the stone covered with the black crust, which appear not to have formed a part of the outside of the meteor but to have received this coating in the interior parts, in consequence of fissures or cracks produced probably by the intense heat to which the body seems to have been subjected. The specific gravity of the stone is 3.6, water being 1. The color of the mass of

the stone is mainly a dark ash, or more properly a leaden color. It is interspersed with distinct masses from the size of a pin's head to the diameter of 1 or 2 inches, which are almost white, resembling in many instances the crystals of feldspar in some varieties of granite and in that species of porphyry known by the name of verd antique.

The texture of the stone is granular and coarse, resembling some pieces of gritstone. It can not be broken by the fingers but gives a rough and irregular fracture with the hammer.

On inspecting the mass four distinct kinds of matter may be perceived by the eye.

1. The stone is thickly interspersed with black globular masses, most of them spherical but some are oblong and irregular. The largest are of the size of a pigeon shot but generally they are much smaller. They can be detached with any pointed iron instrument and leave a concavity in the stone. They are not attractable by the magnet and can be broken with the hammer.

2. Masses of yellow pyrites may be observed. Some of them are of a brilliant golden color and are readily distinguished with the eye.

3. The whole stone is thickly interspersed with metallic points, many of them evident to the eye, and they appear numerous and distinct with a lens. Their color is whitish and was mistaken by the discoverers of the stone for silver. They appear to be mainly malleable iron alloyed with nickel.

4. The lead-colored mass which cements these things together has been described already and constitutes by far the greater part of the stone. After being wet and exposed to the air the stone becomes covered with numerous reddish spots, which do not appear in a fresh fracture and arise manifestly from the rusting of the iron.

Finally, the stone has been analyzed in the laboratory of this college according to the excellent instructions of Howard, Vauquelin, and Fourcroy. The analysis was hasty and intended only for the purpose of general information. The exact proportions and the steps of the analysis are reserved for more leisure, and may be given to the philosophical world through another medium. It is sufficient for the general reader to be informed that the stone appears to consist of the following ingredients: Silex, iron, magnesia, nickel, and sulphur.

The two first constitute by far the greater part of the stone; the third is in considerable proportion, but much less than the others; the fourth is probably still less, and the sulphur exists in a small but indeterminate quantity.

Most of the iron is in a perfectly metallic state; the whole stone attracts the magnet, and this instrument takes up a large portion of it when pulverized. Portions of metallic iron may be separated, so large that they can be readily extended under the hammer. Some of the iron is in combination with sulphur in the pyrites and probably most of the iron is alloyed by nickel.

Quantitative analysis by Silliman gave the following results:

SiO_2	Fe_2O_3	MgO	NiO	S	CaO	Al_2O_3	Cr_2O_3	MgO	
51.5	38.0	13.0	1.5	1.0	....	.....	.....	....	=105.

Warden [2] gave the following description and analysis:

This meteoric stone is surrounded with a thin, black, wrinkled crust. It is composed for the most part of a granular, readily breakable substance, of an earthy appearance and ash-gray color, which in some places inclines to a grayish white. The particles which have the latter color are rounded and, as it were, kneaded into the rest of the mass so that they form round or oval specks in the gray mass. The sharp corners scratch glass. The specific gravity is not far from 3.3.

Upon the fractured surface the stone shows: (1) Individual grains, which may be readily removed from the cells in which they are embedded, which resemble the mass of the stone, except that it is more compact and of a more uniform fracture; in a bright light traces of a laminated texture may be observed; (2) grains of iron which become white by polishing, flatten out under the hammer, and attract the magnetic needle very noticeably; (3) grains of oxidized iron of a rusty color; (4) extremely small metallic particles of a silver-white color, which I took for iron particles, since the native iron of Kamsdorf and the pseudovolcanic is silver white in some places. I obtained no traces of iron sulphide although the analysis indicates its presence.

All portions of the stone are attracted by the magnet but no polarity is apparent. The iron is plainly visible in some places and is so interspersed throughout the rest of the mass, in which it is not visible, that the smallest particles into which it can be divided follow the magnet. I observed this peculiarity even in the above-mentioned particles. From this meteoric mass have been obtained stones weighing 6, 8, 36, and even 100 pounds.

The analysis yielded the following results:

Silica	41
Sulphur	2½
Chromic acid	2½
Aluminum	1
Lime	3
Magnesia	16
Oxide of iron	30
Oxide of manganese	1½
Loss	3
	100

An estimation of the height, direction, velocity, and magnitude was made by Bowditch.[3] His conclusions were that the course of the meteor was south 7° west, in a direction nearly parallel to the earth and at a height of about 18 miles. It was visible for a distance of 107 miles, and its velocity was about 3.5 miles per second.

Herrick[4] studied the path and velocity of the meteorite, with the following results:

The meteor which cast down stones in several places in and about Weston, in this State, on the morning of Monday, December 14, 1807, excited uncommon attention far and wide, and full accounts of its interesting phenomena were published in the highly valuable memoirs of Professors Silliman and Kingsley and of Doctor Bowditch. To the elaborate calculations of the latter we are indebted for our knowledge concerning its height, direction, velocity, and magnitude.

The case of the Weston meteor is one of exceeding importance, because it is probably the only instance where a meteor from which stones are known to have come to the earth has been sufficiently well observed for the determination of its velocity. This element is of great value on account of its bearing on the relation between meteorites and shooting stars. There can, indeed, be no reasonable doubt that many of the meteors which have been seen and heard to explode, and whose phenomena have been submitted to calculation, were true meteorites; but this is a case where there is absolute certainty.

Doctor Bowditch ascertained that the course of the Weston meteorite "was about south 7° west, in a direction nearly parallel to the surface of the earth, and at the height of about 18 miles." It was about a mile farther from the earth's surface when it exploded than when it first appeared. The length of its path from the time it was first seen until it exploded, as determined from the observations made at Rutland, Vermont, and at Weston, was at least 107 miles. This space being divided by the duration of the flight, as estimated by two of the observers, viz, 30 seconds, we have for the meteor's relative velocity about 3.5 miles a second. The observations made at Wenham, Massachusetts, are probably less exact in this respect and need not be mentioned here. Every one accustomed to observations on meteors knows how difficult it is accurately to determine the duration of their visible flight. An inexperienced observer, however intelligent, will frequently give the time ten or even twenty fold too large. The apparent motion of the Weston meteor was probably much slower than that of most meteors, but it seems to me highly improbable that its visible flight could have exceeded 15 or 20 seconds. Mr. Page, the observer at Rutland, Vermont, says: "Motion very rapid, probably 30 seconds in sight." The arc traversed by the meteor as there seen was not over 15°. Now, it is scarcely credible that any man could consider as very rapid the motion of a meteor at the rate of 1 degree in 2 seconds of time. It will perhaps be deemed improper to introduce here, at this distant period, the recollected observation of one not unversed in science, who saw the meteor from a spot a few miles northwest of this city, and who is confident that it could not have been in sight as long as 10 seconds. I will therefore make no further use of his testimony. There are, however, two considerations which may throw some light on this point.

1. The meteor, if a satellite, must have moved with a velocity greater than 3.5 miles per second, because if it did not the earth's attraction would soon have brought the whole mass to the ground. But it is certain that much the greater portion passed on. In order to have done this, through the air, at the height of 18 miles, it must have had a velocity not less than 5 miles per second.

2. According to Mr. E. Staples (one of the observers at Weston), "when the meteor disappeared, there were apparently three successive efforts or leaps of the fireball which grew more dim at every throe and disappeared with the last." Soon after the meteor disappeared were heard three principal heavy reports, which "succeeded each other with as much rapidity as was consistent with distinctness, and altogether did not occupy 3 seconds." Professors Silliman and Kingsley, who thoroughly examined the region where the stones fell a few days after the event, say: "We think we are able to point out three principal places where stones have fallen, corresponding with the three loud cannonlike reports, and with the three leaps of the meteor." The account given by Mr. Isaac Bronson of an investigation made December 19, 1807, by himself and Rev. Horace Holley confirms this position.

(1) The most northerly fall was in Huntington, on the border of Weston, near the house of Mr. Merwin Burr. (2) The second principal deposit was near the house of Mr. William Prince, "in Weston, distant about 5 miles in a southerly direction from Mr. Burr's." (3) The third and probably the largest collection fell near the house of Mr. Elijah Seeley, "at the distance of about 4 miles from Mr. Prince's."

Although it is not certain that these several masses came in the same direction from the meteoric body, yet until the contrary appears, it may, not unfairly, be assumed that they did; and consequently the interval of space at which they struck the earth furnishes some measure of the velocity of the meteor relative to the earth's surface. The statement will permit us to allow not quite a second of time between each report, and we thus obtain a velocity as great as 4 or 5 miles a second. This result is of course no more than a rude approximation to the truth.

The velocity thus far spoken of is only the velocity relative to the earth. Here the question arises, if the meteor was not a satellite of the earth, what was its absolute rate of motion? Now, it will be noticed that the path of the meteor must have been nearly in the same direction with that of the earth at the time. Their directions in azimuth were almost identical; the direction of the meteor's path in altitude appears to have been a little below that of the earth. If the meteor was moving around the sun, then nearly the whole of the earth's velocity (at that season) of rather more than 19 miles a second must be added to the meteor's relative velocity to obtain the true velocity. In this view its absolute rate of motion will be found to have been at least 20 miles a second.

It remains only to inquire whether it is more probable that the Weston meteorite was a satellite of the earth or a primary body moving around the sun. If the meteor had passed the earth's surface in the direction opposite to that of the earth's motion, with about the relative velocity which it exhibited, then we might be compelled to consider it a satellite of the earth. But the peculiar direction in which it moved makes it an ambiguous case. We must, therefore, resort to other instances for a solution of the question. Numerous observations on meteoric fireballs which were without doubt real meteorites have been made and computed. It has most generally been found that whenever they come in a direction more or less opposed to that of the earth's motion their velocity is greater than 10 miles a second, which proves them to be in revolution about the sun and not about the earth. Their velocity has indeed more than once exceeded 30 miles a second. It is then from analogy altogether probable that the Weston meteor was a body revolving around the sun, and that if it approached the earth from the contrary direction it would have been found moving with a relative velocity of not less than 40 miles a second.

Partsch [5] described the specimens in the Vienna collection as follows:

The groundmass shows two different colors, a dark ash gray and a bright grayish-white. These generally appear in one and the same stone beside each other, though they may perhaps also alone constitute small stones. Also, the fragments which we have seen are the same grayish-white and often dotted with brownish flakes of rust and others dark ash-gray, showing that stones of different falls are indicated. The spherical aggregates are very noticeable in the stone of Weston. They occur in great quantity and perfection but of small size, though on the darker portions they are somewhat more distinguishable. Metallic iron is present in small quantity but finely scattered. Yet finer is the troilite, easily seen on broken surfaces and crust with very rough and uneven lines or shimmering. This is a characteristic and easily recognizable variety of meteor stone.

Shepard [6] mentioned the occurrence of—

mica in a single instance in small, brownish-gray, pearly scales attached to a mass of nickeliferous iron weighing 54 grams from the meteoric stone of Weston.

Shepard [7] also gave a brief description of the meteorite as follows:

Its crust is thicker than in the majority of our meteoric stones, though less perfectly continuous and well formed, being rough, dull, and filled with crevices. The color is brownish-black. When broken, the interior shows occasional joints with plumbaginous coatings. The prevailing color within is a dark pearl-gray. Scattered through the mass at frequent intervals are patches of a lighter color, imparting to it a subporphyritic aspect. These lighter portions do not consist of a perfectly homogeneous mineral, but rather of a semipulverulent substance, which is probably decomposing howardite. The main ingredient of the meteorite is a purplish-gray (sometimes greenish-gray) mineral, in rounded grains, which appear to be olivinoid. These again are mixed with other imperfectly formed grains of a lighter colored yellowish mineral (often stained by oxide of iron). This latter substance is taken for howardite also. Magnetic pyrites (less abundant than in most stones) is irregularly disseminated in highly tarnished grains.

The nickel-iron is more abundant than in any meteoric stone yet described, presenting itself not only in little points, but in continuous threads and veins and in oval-pitted masses, sometimes of more than 50 grams weight. One of these, in my possession, strikingly resembles in shape some of the lumps of meteoric iron in their natural state.

Reichenbach [8] gives several observations regarding Weston, as follows:

The dark-gray meteorites, including Weston, show markings resembling a fine network of small, hackly particles of iron, where present in sufficient quantity to appear, which make a network throughout the whole stone.

* * * * * * * * *

Weston is a conspicuous example of "meteorites in a meteorite," i. e., one which contains so many inclusions of all sorts of crystals and other bodies as to resemble a breccia or sandstone conglomerate.

* * * * * * * * *

A small piece of Weston the size of a hazelnut, among others of the same sort, shows an appearance of having lain for some time under leaves, which, however, was not the case, and it appears more or less etched about the edge. Upon the exterior one can detect parallel streaks of a blackish roughness which run around it. These are evidently the blackish points of its layers of formation. If one strokes them with the finger, with a somewhat soft skin, one sees that these are not mere inequalities of the stony matter, but that they are sharp, needlelike projections which appear under the glass as iron. Here the iron network lies open on a small scale, just as it does on a large scale in the case of the Pallasites. One sees herein the part which the iron plays in the structure, although this aerolite does not belong to the stones richest in iron.

* * * * * * * * *

Weston is an example of many stones with a flecked appearance, in which the greater portion of the stone is gray, with sharply defined specks of a whiter color in it, or the reverse, so that the stone acquires a spotted appearance.

In 1869 the account of the meteorite originally given by Silliman and Kingsley was republished in the American Journal of Science,[9] but no new data seem to have been recorded.

A portion of a mass (3.49 grams) in the Yale College collection was tested by Wright[10] in 1876 for gases, and the following results obtained:

H	CO_2	CO	N	CH_4	
13.06	80.78	2.20	2.33	1.63	=100.00

Traces of chlorine were also obtained.

Meunier[11] classed the meteorite as Limerickite, the characteristics of which are as follows:

Coherent rock of bluish ash-gray color inclosing small, more friable white grains. The principal mass is formed of magnesian silicates, some of which resist the action of acids while others are attacked. Nickel-iron and troilite are easily visible. Analysis shows the presence of chromite.

Brezina[12] in 1885 classified Weston as a breccialike spherical chondrite. He says:

Tschermak classed Weston as Cw+Cc, which would be correct if part were white and the rest spherically chondritic, so that the loose chondri were only in the gray portions. This, however, is not the case, the chondri being found in both parts equally.

Newton[13] noted that the nickel-iron in Weston formed a system of lamellæ resembling that of the Widmannstätten figures, when viewed in a certain light upon a polished surface of the stone.

Farrington[15] called attention to a symmetrical distribution of the masses of the meteorite by weight in falling, as follows:

In connection with the meteorite fall which occurred at Weston, Connecticut, December 14, 1807, a well-marked distribution of the masses according to weight took place to which attention does not seem to have been called in detail hitherto. In Silliman and Kingsley's account the fact is noted that stones fell from the meteorite at six different places, over an area 9 to 10 miles in length. It is stated by these authors that these masses fell in a line differing little from the course of the meteor, and probably in the order of the most northerly first and the most southerly last. The relation of the weight of the masses to this order was not traced by these authors, however. This relation as shown by the subsequent account is as follows: The most northerly fall (near Mr. Burr's) broke into fragments from striking a rock of granite. Its estimated weight was 20 to 25 pounds. The next fall was at Mr. Prince's, 5 miles south from Mr. Burr's. This stone weighed 36.5 pounds. About half a mile northwest of this, however, one was found weighing 7 to 10 pounds, and half a mile northeast one weighing 13 pounds. These two masses were doubtless related to the 36-pound mass. The next mass in a southerly direction was found 2 miles southeast of Mr. Prince's, at Mr. Porter's. This was also broken, but is regarded as having weighed from 20 to 25 pounds, and was probably also related to the 36-pound mass. The largest mass of all fell near Mr. Elijah Seely's, about 4 miles from Mr. Prince's. The direction of this locality from the others is not stated, but from the context there can be little doubt that it was south. This mass weighed about 200 pounds. The distribution of the masses thus shows a distinct arrangement according to weight and direction. As Bowditch determined by an independent investigation that the course of the meteor was south 7° west, it is evident that the smaller stones fell first. The distribution of the masses, as above noted, also accords with the statements of several witnesses at the time that the sound of three separate explosions accompanied the passage of the meteor. The smaller masses near Mr. Prince's were evidently thrown off at the time of the second explosion.

Although so large a quantity of stones fell from this meteorite only a small portion seems to have been preserved. Wülfing[14] lists only 18,267 grams as preserved, or about 40 pounds. Of this the Yale University collection possesses the largest amount, 15,300 grams, or about 30 pounds.

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White Sulphur Springs. See Greenbrier County.

Whitfield County. See Dalton.

WICHITA COUNTY.

Texas.
Here also Austin 1836, Brazos, Red River 1875, and Young County.
Latitude 33° 12′ N., longitude 98° 40′ W.
Iron. Coarse octahedrite (Og) of Brezina; Arvaite (type 7) of Meunier.
Known since 1836; described 1860.
Weight, 145 kgs. (320 lbs.).

The first account of this meteorite was given by Shumard [1] as follows:

The interesting specimen of meteoric iron we are about to describe is preserved in the State Geological Cabinet at Austin, where at our earnest solicitation it was deposited by the late Maj. R. S. Neighbors, United States Indian agent, who obtained it during the month of May, 1836, from the eastern side of Brazos River about 60 miles from the Comanche Reserve, in latitude 34° N., longitude 100° W.

The history of this meteorite as furnished by Major Neighbors is in substance as follows:

For many years its existence was known to the Comanches, who regarded it with the highest veneration and believed it possessed of extraordinary curative virtues. They gave to it the names Ta-pic-ta-car-re (Standing Rock), Po-i-wisht-car-re (Standing Metal), and Po-a-cat-le-pi-le-car-re (Medicine Rock), and it was the custom of all who passed by to deposit upon it beads, arrowheads, tobacco, and other articles as offerings.

According to the Indians the mass was first discovered by the Spaniards, who made several ineffectual attempts to remove it on pack mules but were finally compelled to abandon it on account of its great weight.

The Comanches at first endeavored to melt the mass by building large fires around it, but failing in this, they next attempted to break it in pieces, in which they were likewise unsuccessful; they then conceived the idea that it was a wonderful medicine stone and therefore worthy of their most profound regard.

When the meteorite was conveyed to the Indian reserve the Comanches collected in great numbers around their valued medicine stone and, whilst manifesting their attachment by rubbing their arms, hands, and chests over it, earnestly besought Major Neighbors to permit them to keep it at the agency. The mass was, however, shortly afterwards (July, 1836) taken to San Antonio, where it remained in the possession of Major Neighbors until last summer, when it was forwarded by him to Austin.

The present weight of the specimen is 320 pounds, but the original weight was perhaps 3 or 4 pounds greater, a piece having been cut off from the larger end before it came into our possession. The form is flattened ovoid, or truncated pyramidal, with the angles more or less rounded. It measures 2 feet in length by 1 foot in width; at the larger extremity the thickness is about 8 inches and at the smaller 4 inches; the surface is marked with irregular, smooth, shallow depressions, and for the most part presents a dark somewhat oily appearance, though in places it is covered with a thin film of oxide of iron. The freshly-cut surface has a bright silvery gray hue which becomes tarnished after being exposed for a time to the air. The iron is remarkable for its toughness and malleability.

An analysis of this iron was made by Prof. W. P. Riddell in the laboratory of the Geological Survey and he has furnished the following statement of its composition:

Agreeably to your request I herewith furnish you a statement of the results of my analysis of the meteoric iron presented to the State Cabinet by the late Maj. R. S. Neighbors:

I. The assay was dissolved in aqua regia, which effected a complete solution.

II. The solution was carefully neutralized by aqua ammonia and then an excess of chloride of ammonium added.

III. The peroxide of iron was precipitated by benzoate of ammonia.

IV. To the filtrate of III excess of caustic potassa was added to precipitate the oxide of nickel. This precipitate exhibited no trace of cobalt, as shown by the blowpipe, etc.

V. The filtrate from IV was next evaporated to dryness and ignited; the residue redissolved in aqua regia and to the solution excess of potassa added; digested for several hours; precipitate very slight, affording only very faint traces of cobalt but decided indications of nickel.

VI. Miscellaneous qualitative tests were made which it is unnecessary here to enumerate, as no other ingredients were detected.

The following is the summary of results:

Nickel	10.007
Iron	89.993
Cobalt	Trace
	100.000

Mallet [4] described the meteorite as follows:

The following is the history of the Wichita County meteoric mass as given me by Hon. Henry P. Brewster, commissioner of insurance, statistics, and history of the State of Texas, a gentleman whose personal knowledge of the State in its early days is extensive and accurate:

The meteorite was found on the upper waters of Red River in what is now the county of Wichita, not far from the Red River itself, on the opposite side of that stream from the part of the Indian Territory at present set apart for the Kiowas, Comanches, and Apaches. It had been set up as a kind of "fetich" or object of worship or veneration by the Indians, "who revered it as foreign to the earth and coming from the Great Spirit," at a point where several converging trails indicated periodical visits to the spot. In 1858 or 1859 Major Neighbors, then commanding at Fort Belknap, sent a wagon after the mass and had it brought into the fort. It was thence sent in a Government wagon to San Antonio and subsequently moved to Austin, and there deposited in the old Capitol building, where it remained until the destruction of the building by fire some three years ago. Removed from the ruins, it was placed in a passage on the ground floor of the temporary Capitol now in use while the new and very handsome structure, intended for the permanent seat of the State government, is being erected. During last winter the meteorite was turned over by the State authorities to the University of Texas and is now preserved in the university building at Austin.

The mass has an irregular, elongated pearlike shape, somewhat flattened, a good deal larger at one end than the other, with tolerably smooth general surface but with well-marked concavities or shallow pittings, in every way presenting the appearance of a typical metallic meteorite. There is no well-defined crust but merely a thin, closely-adhering film of oxide on the surface. There is no appearance of any effect from the Capitol fire through which it passed; very probably the weight of the mass may have carried it rapidly, on the giving way of the floor, down to some position in the basement in which it was sheltered from the heat by masonry rubbish accumulated over it. The dimensions of the specimen in its original state were—

	Mm.
Maximum length	595
Maximum breadth	305
Maximum thickness	223

The weight was a little under 160 kgs., as determined on a rather rough platform balance.

A piece was cut off one end in order to display the character of the interior. Most of the iron was compact and tolerably soft, tough, and malleable. Here and there occurred nodules of troilite of considerable size, the principal ones ranging from 5 or 6 up to 23 mm. in diameter. Signs of the presence of thin plates of schreibersite could be seen even without the use of acid, but that ingredient is not very abundant. The average specific gravity of the whole mass was probably pretty fairly represented by that of a slice weighing 204 grams, which was found=7.841 at 24° C.

A polished surface having been etched with nitric acid, Widmannstätten figures were clearly brought out, the broad bands of crystalline nickel iron (with finer subordinate markings upon them) contrasting strongly with the more sparingly occurring, well-defined lustrous lines of schreibersite.

Chemical analysis of an average sample of the shavings taken off by a planing machine in cutting through the mass gave:

Iron	90.769
Nickel	8.342
Cobalt	0.265
Manganese	Trace
Copper	0.018
Tin	0.004
Phosphorus	0.141
Sulphur	0.016
Graphitic carbon	0.190
Silica, Magnetic oxide iron	0.132
	99.877

A separate examination of the troilite nodules proved them to consist of ferrous sulphide with a little nickel and traces of manganese and chromium. The nickel may very possibly have existed in the form of minute granules of nickel iron or schreibersite, and the chromium may in like manner be referred to an admixture of little particles of daubréelite.

The most interesting point about this specimen is perhaps the probability of its forming a separate portion of the same meteoric fall from which was derived the large iron meteorite, weighing 1,635 pounds, first described by Colonel Gibbs in 1814, and which has long been a prominent object in the mineralogical collection of Yale College at New Haven, Connecticut. The latter is said to have been found "near the head of Trinity River, a few miles west of the Cross Timbers, Texas, latitude 32° 7′ N., longitude 95° 10′ W. of London." It is said to have been "one of a large number of meteoric masses which are reported to exist at the locality mentioned above." The statement of locality is not quite clear; the spot designated by latitude and longitude is in the northern part of the present Cherokee County near the line of Smith County and rather on the headwaters of the Neches than of the Trinity, though not far from the latter and about 240 miles from the locality of Wichita County where the meteorite now described was found. Even such a distance perhaps does not altogether exclude the idea of simultaneous fall, and it is of course quite possible that the mass found to be regarded with attention and veneration by the Indians may have been carried to the spot where they afterwards preserved it. There seems to be some uncertainty as to how many meteoric irons from Texas have before now been noticed and are to be found in the mineralogical collections of the world. In a catalogue of the collection of Prof. C. U. Shepard, published in 1857, in the second part of his treatise on mineralogy, page 436, there is mentioned a meteoric iron from "Texas (Red River), U. S. A., found in 1808." In Rammelsberg's Handbuch der Mineralchemie (Leipzig, 1860) are noticed, page 917, specimensfrom "Red River in Louisiana," and from "Texas," with the statement that according to Partsch these are probably identical; this opinion is undoubtedly correct; the analyses quoted show that both represent the Yale College specimen. In the recent (1880) catalogue of meteorites in the collection of the Indian Museum at Calcutta No. 108 is quoted on page 38 as two specimens from "Red River,Texas, U. S. A., found in 1814," No. 27, on page 31, as a specimen which "apparently has been fired, from Denton County, Texas, U. S. A., found in 1856," and No. 39, on page 32, as from "Brazos River, Texas, U. S. A., found in 1856." It may be questioned whether Nos. 27 and 39 refer to portions of the same or of different masses; the same date is given, but the shortest distance from any part of Denton County to the Brazos is about 40 miles, this county being traversed by affluents of the Trinity. The specific gravity of the iron now described agrees closely with that reported for the Gibbs meteorite of the Yale College collection. The results of the chemical analysis are also very similar to those obtained for the latter by B. Silliman, jr., and Hunt. It is stated that this latter "incloses a few small masses of magnetic pyrites"; this statement probably referring to troilite nodules like those which are conspicuous inclosures in the University of Texas specimen. The Widmannstätten figures developed by etching this University of Texas iron do not closely resemble those of the Yale College specimen, as shown in a lithographed figure published in connection with the (Göttingen) inaugural dissertation on metallic meteorites of William S. Clark (1852), copied from one published by Prof. B. Silliman, jr., but the difference in appearance may be largely due to difference in the planes of section in relation to those of crystallization in the particular pieces submitted to the etching process.

In the Vienna Catalogue for 1885 Brezina [5] groups Wichita among octahedrites with coarse lamellæ, Arva group, and describes it as follows, giving two plates to illustrate its appearance:

Most striking are the great troilite inclusions which are surrounded with a shell of graphite, then one of schreibersite, finally one of swathing kamacite. * * * Wichita shows very beautifully on account of the great length of its bands, extraordinarily long fields, which are filled partly with dark plessite, partly with combs.

From the structure, Brezina further asserts the improbability of a union of Wichita with Cross Timbers.

Cohen and Weinschenk [8] give the following analyses of some shavings and a section of this meteorite:

For the shavings—

Fe	Ni	Co	
91.67	7.93	0.40	=100

For the section—

Nickel iron	85.41
Tænite	1.47
Schreibersite	6.07
Crystals resembling cohenite	6.04
Angular fragments	1.01
	100.00

The crystals of cohenite gave:

Fe	Ni	Co	C	
82.42	9.96	2.20	5.08	=99.66

The cohenite is described as brittle and metalloid.

The tænite gave:

Fe	Ni	Co	Cu	P	Schreibersite	
60.73	30.46	1.46	trace	0.16	5.73	=98.54

As the above analysis of cohenite gave a formula $(Fe, Ni, Co)_4 C$, instead of the formula $(Fe, Ni, Co)_3 C$ obtained for the cohenite of other meteorites, the cohenite of Wichita was studied again by Cohen,[9] and the following result obtained from an analysis by Sjostrom:

Fe	Ni	Co	C	
90.80	2.37	0.16	6.67	=100.00

This result gives the formula $(Fe, Ni, Co)_3 C$.

The following series of analyses by Manteuffel is given by Cohen:[9]

	Fe	Ni	Co	Cu	P	C	
I.	92.37	6.74	0.59	0.03	0.03	....	=99.76
II.	92.67	6.71	0.59	0.03	....	....	=100.00
III.	89.36	8.62	0.72	0.02	0.97	0.31	=100.00
IV.	92.26	7.13	0.58	0.03	....	....	=100.00

I. Analysis of a portion obtained from a section of Wichita.

II. After deduction of the schreibersite reckoned from the phosphorus.

III. The chemical composition reckoned from the now accessible determinations, when we assume for the unanalyzed schreibersite the formula $Fe_2 Ni P$ with 1.30 per cent Co, and identify the angular fragments with the kamacite.

IV. After deducting schreibersite and cohenite.

Mineralogical composition:

Kamacite	84.98
Tænite	2.64
Schreibersite	6.34
Cohenite	6.04
	100.00

The structure of the iron is thus described by Meunier:[10]

This is a remarkable stone, in which the pencils of schreibersite are quite numerous and exceptionally well oriented. In reality, they are more or less discontinuous and their thickness is not entirely uniform. The angles at which they intersect are entirely conformed to those of the octahedron. The schreibersite consists of masses with more or less irregular outlines often measuring 1 cm. in longest diameter, and a sort of envelope to which other substances contribute, particularly graphite about the pencils of pyrrhotine. These pencils often attain large dimensions. One of them measures, in section, 20 by 11 mm. The sulphide contained in them is very pure and of a perfectly uniform bronze shade; certain cavities appear in them which may have resulted from the process of polishing. The exterior surface is covered with a secondary coating of graphite, very even, compact, and black, unequally thick near the points and whose outlines appear to be nevertheless ordered according to those of the sulphide. There is a minimum of very nearly zero at the two extremities of the small diameter of the kidneys and a very obvious maximum at the two extremities of the large diameter. In many places this envelope of graphite is covered again with a coating of pyrrhotine identical in appearance with that of the central mass, and is separated from the schreibersite envelope by a very thin film of graphite.

This, as will be observed, is a most remarkable structure, and one which recurs in its most general features in the heart of many other meteoric irons.

By etching, the Wichita meteorite gives Widmannstätten figures in which the kamacite frequently attains a size of 2 mm. Among these, filaments of tænite frequently appear, often of an isabell-yellow color which distinguishes them very definitely from the steel-gray groundmass.

In the above description Meunier seems to have confused schreibersite with cohenite, the latter being an abundant and important constituent of this iron.

In the Vienna Catalogue for 1895, Brezina[11] further described the structure of Wichita as follows:

Wichita shows frequent alternations between portions nearly free from cohenite and similar portions bearing cohenite, and is distinguished by the manifold character of the outcroppings of troilite and graphite, which usually show a corona of schreibersite and over this, less frequently, still another zone of cohenite, and finally a coating of swathing kamacite. Graphite and troilite alternate in the lumps which attain as much as 6 cm. diameter, now zonewise, usually beginning with the troilite in the center, less frequently with the graphite; again, but not so frequently, lying side by side. The graphite occurs as bands between the core and the periphery of the troilite lumps, and thus it has sometimes a perfectly uniform width (in one case of 0.5 mm.) and follows all the inequalities of the exterior. On one place in the trias there occurs an outcropping of cohenite with schreibersite envelope, and more frequently with a corona of cohenite. The schreibersite is for the most part finely porous; the cohenite shows individual fissures, but is otherwise smooth and of a bright luster.

The name of Brazos has been often applied to this meteorite but if Mallet is right in stating that it was found in Wichita County, Brazos is inappropriate as the Brazos River runs far south of Wichita County.

The meteorite is chiefly preserved in the University of Texas.

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WILLAMETTE.

Clackamas County, Oregon.
Latitude 45° 22′ N., longitude 122° 35′ W.
Iron. Coarse octahedrite (Og) of Brezina.
Found 1902; described 1904.
Weight, 13.5 tons (27,000 lbs.), computed.

The first scientific mention of this meteorite appears to have been by Kunz [1] who gave the following account:

This great meteoric mass was found in the autumn of 1902 by Mr. Dale, a prospector, on land belonging to the Oregon Iron and Steel Company about 2 miles south of Oregon City. The official statement of its location is T. 2 S., R. 1 E. of Willamette meridian. It was dug loose from the soil and removed on a truck to adjacent land belonging to Mr. Ellis Hughes, where a suit is now (January, 1903) in progress for its recovery. The mass is roughly conical or dome-shaped, extensively pitted and at one point perforated. The mass measures 10 feet in length by 7 in width and 5 in height.

In February, 1904, the locality was visited by Ward and a full account of the meteorite was given by him as follows:[2]

This most interesting meteorite, noble in size and wonderful in physical features, was found near the border of Clackamas County, Oregon, in the autumn of 1902. At this point in its course the Willamette River, 80 miles south of its junction with the Columbia, runs between high banks of sedimentary rocks. At Oregon City, 16 miles south of Portland, these banks come as cliffs down close to the river, which on the western side they follow southward for 3½ miles to the town of Willamette. This meteorite having been found 2 miles from this town (to the northwest), I have given it the name Willamette meteorite. Its exact locality is latitude 45° 22′ N., longitude 122° 35′ W. The region immediately surrounding is a series of hills, distant foothills of the Cascade Range, with their steeply sloping sides cut into by streamlets flowing into the Willamette. One of these streams is the Tualitin. On a hillside, 3 miles above the mouth of the Tualitin, fell, apparently centuries ago, the Willamette siderite, the third largest iron meteorite in the world. The region is a wild one, covered by a primeval forest of pines and birch, little visited and largely inaccessible. Here on the spur of the hill in a small level area lay the great iron mass, lightly buried in soil and the carpet of accumulated vegetable débris. In the valley, half a mile away, there lives with his family, a humble, intelligent Welshman, Mr. Ellis Hughes. He had formerly worked in Australian mines. He had with him in 1902 a prospector named Dale, and together they roamed over the hills seeking minerals. One day a blow on a little rock projecting from the soil showed it to be metal. They dug and found its great dimensions and learned that it was iron. It was on land which they learned belonged to a land company. For some months they kept the find a secret, hoping to buy the land on which the "mine" was located. Some months later they ascertained in some way that their supposed iron reef, which they had found to be but 10 feet long and a yard or more deep, was a meteorite. They became more secretive than ever and covered their find most carefully.

In August, 1903, Mr. Dale in the meantime having left the country, Mr. Hughes conceived the idea of bringing the great iron mass to his house, a distance of nearly three-fourths of a mile. This seemed an almost impossible task, he having only his son of 15 years and a small horse as motive power. But he was an old miner, full of mechanical resources, and also full of pluck and energy. With infinite pains he fashioned a simple capstan with a chain to anchor it and a long braided

wire rope to roll up on it, as his horse traveled around, as a winch. Then he fashioned an ingenious car with log body timbers and sections of a tree trunk for wheels, also some heavy double-sheaved pulleys. By wearisome blocking up and leverage he succeeded in capsizing the great mass directly upon the car and lashed it there securely. Then he stretched out his 100-foot hauling wire rope, attached one end of it to the car and the other to his staked-down capstan and started his horse around. The great mass moved slowly for the ground was soft and, even with boards put under them and constantly changed, the wheels sank deep into the mud. Some days they moved little more than the length of the car, on others they covered 10, 20, and one day 50 yards. After three months of almost incessant toil the giant meteorite reached Hughes's own land, where it now rests.

The Hughes, father and son, had worked unobserved for all these months in the dense forest. Their nearest neighbors, a mile away, do not seem to have been aware of what they were doing. But when the great find was announced people came trooping up the little valley, first from near-by Willamette, then from Oregon City, and then from Portland to see the celestial wonder. News soon came to the Portland Land Company and they promptly claimed the meteorite as having been taken from their land. Hughes refused to give up possession, which latter he believes is a strong point in the matter. So a suit at law has commenced with all prospects of a stoutly fought legal battle. The suit should come off during the spring of 1904, but it may be delayed. Public opinion is divided as to the probable outcome, but sympathy lies mainly with Hughes, the finder of the mass, who is the only man in common life or among scientific collectors on record as having run away with a 14-ton meteorite.

The dimensions and shape of the mass are given by Ward as follows:

Extreme length, 10 feet 3.5 inches. Extreme breadth across base, 7 feet. Extreme vertical height from base to summit, 4 feet. Total circumference of the base, 25 feet 4 inches. The upper dome part is circular in form; from the middle point to the base it expands before and behind into an oval form. * * * But regarding the mass at a right angle to this, which gives an end view, the sides of the central dome part are almost vertical, with very little enlargement or flaring.

The meteorite has thus the form of a huge abbreviated cone, having its base on two sides so prolonged as to produce an oval, whose long diameter is one-third greater than its transverse diameter. There are no angular outlines to the mass as a whole; all, whether in vertical or horizontal section, is bounded by broad curves.

The mass lay buried in the ground with the point downwards. This position, with the apex or cone buried below, is unquestionably the one which it held when it passed through the earth's atmosphere. Its front face in its flight was the apex of the cone. All features of the surface harmonize with this view. The upper half of this apex is devoid of any striæ such as frequently occur on the front surface of a stone meteorite. Nor are there here any well-defined pittings. If these have ever existed they are now completely effaced. This part of the great mass seems to have undergone but one change since it entered our atmosphere and was subjected to the friction of the air. The denuding influence of this friction may well be considered to have induced the generally round and even character of the upper cone, though no fine polish or striation remains. The one effect noticeable on all this area is the presence of little spots or patches from 1 to 3 or 4 cm. in length, of material which seems more dense and of a faintly deeper shade than that of the main mass. These appear over all the surfaces in question, sprinkled indiscriminately, without order or alignment. They stand slightly elevated above the level of the surface, and might be called scabs. I am disposed to regard them as flows of melted matter, which were once more widespread or contiuuous, but now show simply as patches.

As to the lower half of the cone, there is first a large border 18 or 20 inches wide, entirely around the mass, which is quite covered with the characteristic pittings, which are well defined and continuous but shallow. They are usually oval in form, with a greater diameter of from 3 to 8 cm. They appear to have no distinct form or alignment; and they meet and merge into one another with only a fuller, slightly pronounced crest between them.

A second feature in this lower half of the great cone is the series of round bore holes, sprinkled irregularly all around it and more generally near the lower border. These holes, which are so noticeable a feature of the Canon Diablo siderite, as also in the Tazewell and Youndegin (Australian) masses, are beautifully sharp and well defined. They are usually nearly circular in section, 1 to 3 inches in diameter, and from 3 to 4 or more inches in depth. These holes, notably those of the smaller diameter, are sometimes materially larger in their inner portions than they are at their outer orifice. This feature, observable also in the Canon Diablo masses, seems to militate strongly, if not conclusively, against any theory of their having been caused by the boring action of the air in the meteorite's downward flight. They are undoubtedly due to the presence of lengthened cylindrical nodules of troilite or some other sulphuret which have subsequently decomposed and have generally dropped out. An interesting specimen in the Ward-Coonley collection is a mass, some 15 inches in diameter, of Canon Diablo iron with such a circular hole, its orifice being open while all the lower part is occupied by the still remaining troilite nodule. In the Willamette iron no less than nine of these holes pierce the mass from its upper surface quite through to the base below.

The third feature of this forward face of the iron is one which now makes it the most remarkable meteorite known to science. This is the existence of deep, broadly open basins and broad furrows or channels cutting down deeply into the mass. The basins are distributed alike over the lower cone area. The furrows reach vertically quite across this belt to the lower edge or base of the mass, whose border they break with deep channeling. These deep bowllike cavities and furrows exist more upon one side of the mass than upon the other. One of these cavities measured 19 inches long by 14 inches wide and 5 inches deep. Others, some of which from their form might be called basins, others caverns, were of various diameters at the mouth, 5 to 10 inches and from 4 to 12 inches in depth. In all cases,

these cavities had their widest extension or opening toward the apex of the cone. Nothing can be clearer than that this was produced by the tremendous friction of the densely compressed air through which the meteorite passed on its way to earth.

The air, which was compressed in front of the mass to a density comparable to that of some solid substance, has flown back past the apex and the sides of the cone with a friction force almost inconceivable in its intensity. The air crowded in front of a meteorite having a velocity of 60 miles per second has furthermore been shown by physicists to have, by reason of its compression, a heat of over 5,000° Centigrade (9,000° Fahr.), a heat calculated to melt away any surface which it enveloped. It is to the melting, rubbing, and chiseling effect of this compressed air, with its following air stream, that we may attribute all the glazing, pitting, hollowing, and channeling which has been observed on the front side of the cone and upon the flaring base of the great meteorite. That the melting should be more complete on the forward part of the cone is easily conceivable. Also, it is clear that the boring and channeling power of the air should be most exercised on the basal flanges, on which it more directly impinged. The effects are colossal, and words but feebly express the impression made by the sight of the great cone, with its torn, excavated sides. It seems impossible in theory, but the whole is made easily credible in seeing and studying the effect.

It is probable that this mass contained great nodules or even long cylindrical inclusions of some mineral softer and more subject to attrition than is the iron of which it seems to be wholly composed. These inclusions may have determined the position and greatly enlarged the size of these excavations. This is particularly true of the long furrows. In these, the upper part of the wall hangs over as a rim, leaving the tube or gutter, as seen from the side, larger within than in its outside exposure. These furrows, as well as one of the holes, gouge deep recesses out of the otherwise continuous border of the mass. The lower part of the cone rolls smoothly around to join its base.

The original surface of the base was slightly crowning; was covered with well-developed normal pittings of great similarity of character in all parts. The remaining areas of this surface are in every case thus covered. Furthermore, we observe the striking manner in which the base of the mass was drilled and bored by the clean round holes. Counting only those that are of limited diameter, there are over 30, varying from 0.5 to 2.5 inches across, and from 3 or 4 inches to an unmeasurable depth. Indeed, quite a few of them which are near the periphery, pass completely through the mass. One of these perforating vertical bores or drill holes is seen at the base of the figures; the other two are visible toward the extreme left. The position of these upon the base, the rear side of the meteorite, argues strongly for their origin from preexisting cylindroid nodules of troilite. The inner trend of some of these bores is quite irregular, and the surface roughened with sharp tortuous ridges. Some few of the holes join each other below, anastomosing as may sometimes be seen in sections of long troilite nodules in the face of a section of siderite. In the frequency of these long round holes and their general distribution over all sides of the mass, the present meteorite resembles, though it surpasses, Canon Diablo.

But attention is strongly drawn away from these aerial features to a most singular and astonishing group of concavities and caverns. Nothing can exceed the labryinthine and chaotic outspread of these. They cross the mass from side to side and from end to end. Yet they have no regularity of distribution or system of alignment. They make a confusion of kettle holes, washbowls, or small bathtubs. One of the latter, crossing the mass diagonally is 3 feet long by 10 to 15 inches across and of an average depth of 16 inches. Another, nearly circular, is 2½ feet in diameter and 18 inches in deepest part. This one is quadrifid in its bottom; each of the four areas being a distinct basin, swelling gently up from its center to the sharp crest running between it and its neighbors. To describe these caverns individually would be impracticable as well as useless. This extraordinary meteoritic phenomenon is evidently produced by decomposition due to the action of water. They are not the product of erosion as are the deep holes and channels of the other side of the mass. There are here no lines of flow, no connections in the nature or trend of the depressions. It has been noted that this meteorite lay in its original bed, as it fell, with the conical end down, and the flat base upward and quite level; that it lay just below the surface of the ground in a soil charged throughout with vegetable matter, the accumulation of centuries under the falling leaves and branches of a primeval forest. Moreover, western Oregon is a region marked as a rain belt ever since its first exploration. Every condition was fulfilled for the decomposition of this great mass of iron, so situated that its surface was always soaked with water heavily charged with carbonic acid, due to vegetable decomposition. Under such conditions the oxidation of the mass would go on rapidly. The depressions would soon be initiated; these would fill with water, and thenceforth the dissolution of the mass would proceed rapidly with ever increasing area and rapidity. This action would never be intermitted or minimized; for while the frosts of the short winter may have materially lessened the chemical action for a time each year, the increased mechanical effects of freezing and thawing would quite compensate for this diminution of the destructive work. It is especially noticeable in studying these caverns that certain portions of the surface of the mass are entirely without them, holding today not only the original superficial level, but also retaining in fullest degree the pittings and all other markings which the mass showed when it fell. These areas of original surface stand as islands in the waste depressions produced by the process of decomposition; and in the majority of cases these intervening areas have been undermined by the same process which produced the caverns. The projecting portion of these areas are frequently penetrated by the noticeable borings already described. Again, the intervening walls between the caverns have been eaten through in at least 10 places, leaving large irregular openings between the large excavations. These basins or caverns have a rough, sandy surface, not to be compared with the smooth semi-polished inner wall of the holes bored by the friction of the atmosphere. The difference is as evident, and somewhat the same, as that between a glaciated rock and a sawed or ground rock surface. Here is again occasion for the supposition that these excavations are in some measure due to the presence of a softer and more easily decomposed

material throughout the mass of iron, such as troilite, only in this case its disappearance would be due to decomposition rather than erosion.

This great meteorite has shown itself to be quite unique in the distinct and essentially diverse phenomena which it presents. On the one hand, it offers the most extensive case of aerial erosion helped by fusion. No other meteorite, whether stone or iron, offers such extensive holes and furrows caused by aerial attrition. On the other hand, it affords a case of discrete decomposition due to aqueous causes, far beyond anything ever before noted on these celestial bodies.

In the presence of these two marks of cosmic power, all other features of the meteorite seem to dwindle. Even its great size loses some of its impressiveness. How great and dazzling and wonderful must have been the illumination within a radius of many hundred miles when this mass fell. With what aerial commotion, explosion, and pyrotechnics must it have traversed the atmosphere and with what unearthly screeching sought its final home, "losing itself in the continuous woods where rolls the Oregon."

The weight of the mass remains to be determined. The mean of several careful computations, based upon numerous measures of its dimensions, and upon the known specific gravity of the iron, makes the meteorite weigh about 27,000 pounds, or 13.5 tons.

An examination of the etching figures of the iron made by Preston is further reported by Ward as follows:

An etched section of the Willamette iron shows it to belong to the octahedral group and to that division (No. 56) which is designated as broad octahedrite (Og). But this structure is somewhat dimmed by numerous small flakes of a very much brighter and more lustrous iron than that of the kamacite blades, and seeming to have no regular or definite form—the largest of them having a diameter of not more than 6 to 7 mm. These plates, at least in part, are apparently hexahedral, as some of the larger ones show Neumann lines on their etched surfaces. The patches of plessite are decidedly small, but occasionally show the alternating layers of kamacite and plessite formerly known as Lapham markings. The tænite lines are plainly visible along the edges of the kamacite plates. There are numerous small troilite nodules from 1 to 3 mm. in size scattered promiscuously throughout the section, and a few rod-shaped ones 1 mm. in width, and in some instances up to 15 mm. in length. The largest troilite nodule found in several sections was 28 mm. in diameter. It incased several small patches of the nickeliferous iron. No schreibersite is apparent to the eye, nor would it be expected from the small amount of phosphorus found in the analysis of the iron. The exterior of the mass in our possession is of a dull reddish-brown color, much oxidized, with a tendency to scale in small flakes. The fractured surface of this iron is much more coarsely granular in structure than that of any other iron with which the present writer is familiar.

Two analyses of the iron are given by Ward, one (1) by Davison, the other (2) by Whitfield:

	Fe	Ni	Co	P	
1.	91.65	7.88	0.21	0.09	=99.83
2.	91.46	8.30	....	....	=99.76

Specific gravity, 7.7.

Winchell [3] gave an account of a suit regarding the ownership of the meteorite and some of the traditions concerning it as follows:

It was decided by the Iowa supreme court, in the case of the Winnebago meteorite, that the meteorite belongs to the owner of the land on which it falls. The tenant found the stone and sold it. The owner brought suit to regain it and after some years of litigation and delay the court assigned the meteorite to the owner of the land.

The Oregon meteorite case is somewhat different. A metallic mass is admitted by both parties to be of meteoric nature and origin, and as such, according to the Iowa decision, it belongs to the owner of the land on which it fell. The date of its fall, however, is unknown and there is evidence tending to show that it was a piece of personal property, separate from the land on which it was found, for many years prior to the date of discovery. The issue and the attendant conditions have been stated as follows by the Oregon Journal:

The Oregon City meteorite case was argued before the supreme court yesterday. This is an action brought by the Oregon Iron & Steel Company to obtain possession of the metallic meteorite found by Ellis Hughes in November, 1902, on the land of the Oregon Iron & Steel Company, about 2.5 miles west of Oregon City. The interesting subject of this controversy was found standing upright on a slight knoll. It is of metallic composition with a dull, rusty surface, its top or flat surface being gouged out into huge pot holes or washbowls. As it stood it resembled very much in appearance a mammoth mushroom or inverted bell, in size, 7 by 10 feet across at the top and 4.5 feet thick, its weight being estimated at from 3 to 4 tons. It has the specific gravity of soft iron, and in composition is 90 per cent soft iron, 10 per cent nickel, with a trace of cobalt.

Hughes alleged that this was an abandoned Indian relic and that he was the first white discoverer of it, and believing he had a right to it he constructed a rude wagon and hauled it to his own home, about ¾ of a mile distant. He alleged that this meteorite was the property of the Clackamas tribe of Indians (now disbanded and nearly all dead), and that they had a tradition that this magic rock, called by them "Tomanowos," came from the moon and possessed supernatural influence. He claimed that it was fashioned, erected, maintained, and used by them to hold the fluid in which they were wont to dip their arrows before engaging in battle with their Indian foes, and that their young warriors were compelled to journey over there and visit this spirit being on the darkest nights. To substantiate these claims two

Indian witnesses were produced who testified that the above facts were true, according to the legends of their tribes. One of them was a member of the Klickitat tribe of Indians and the other was a Wasco Indian.

Both parties to this case agree that the object is a meteorite but no proof has been offered by either to show when it arrived on the earth. The Oregon Iron & Steel Company denies that it is an Indian relic and claims title to it by virtue of ownership of the land upon which it was found.

It may safely be assumed, probably, that this iron fell on the land where it was found although there is no proof of it. The Indians who previously visited and worshipped it could not have transported it. If they had ownership of the land they owned the specimen. As they did not remove it when the land passed from them it would seem that the meteorite went with the land. But the consideration that they had used it as a special object, for a special purpose, foreign to the uses to which land as such is devoted seems to make it an object of personal property. They may have erected it in the position in which it stood and may have deepened the "potholes" on its upper surface. If a man sculptures a statue from some rock on his land, when he sells the land the statue does not go with the land. If the Clackamas Indians did not own the land, and yet visited and controlled the specimen for a specific use without objection from others, it seems reasonable to assume that the specimen was not an appurtenance of the land and that they had a right to remove it. If they abandoned it, without removal, it seems to belong to that class of Indian relics of which many examples are known and of which the finder, rightly or wrongly, becomes the owner.

If the specimen is an Indian relic the ownership thereof may still be in the owner of the land. He is a trespasser who wilfully passes on to his neighbor's domain; and he is still more a trespasser if he removes, against the owner's protest, any of the property of his neighbor.

NOTE.—Since the foregoing was written the Oregon supreme court has decided this case as follows as published in the Portland Oregonian:

Oregon Iron & Steel Company, respondent, *vs.* Ellis Hughes, appellant, from Clackamas County, T. A. McBride, judge; affirmed; opinion by Chief Justice Wolverton.

Held, that a meteoric rock is a part of the real property upon which it falls, and evidence that Indians worshipped the rock and dipped their arrows in the water held in its cavities is not sufficient to show that the Indians had dug the rock from the ground and acquired title to it as personal property. The question whether Indian ownership and abandonment is sufficient ground upon which to predicate title in the finder is not decided.

The court did not consider the evidence as to the ownership of the specimen as personal property by the Indians of sufficient force to warrant the reference of the case to a jury for determination. That evidence failing, there was left the bare question as to whether the meteorite belonged to the real estate or to the finder. In that the Oregon court coincided with the Iowa court *in re* Winnebago meteorite.

The meteorite is chiefly preserved in the American Museum of Natural History.

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Williamsport. See Bald Eagle.
Wilson County iron. See Cocke County.
Wilson County stone. See Cross Roads.
Winnebago County. See Forest City.
Wisconsin, 1858. See Trenton.
Wisconsin, 1884. See Hammond.

WILLIAMSTOWN.

Grant County, Kentucky.
Iron. Medium octahedrite (Om) of Brezina.
Found, 1892.
Weight, 31 kgs. (68 lbs.).

This meteorite was described by Howell [1] as follows:

This siderite was secured from A. E. Ashcraft, who found it April 25, 1892, on his farm in Grant County, Kentucky, 3 miles north of Williamstown. It is a thin flat rectangular mass measuring 12 by 16 inches; it is 2.5 inches thick in the center thinning to a blunt edge at either end, looking not unlike a large double-edged axe. The total weight of the mass was 68 pounds, or about 31 kg., and had a specific gravity of 8.1. It was entire when it reached me with the exception of a few ounces broken from one of the thin edges. We have cut the iron into a number of sections which etch very readily, showing it to be a typical octahedrite of medium coarseness, as seen in the accompanying full-size cut of one of the smaller sections. It will be seen from this cut also that the kamacite bands are massed together to a considerable extent, leaving an unusually small number of plessite blocks; these when deeply etched are seen to be

crossed by minute parallel, broken threads of tænite. In addition to the three regular distinct systems of kamacite bands there is another, less regular, system of broader bands averaging in width about 3 mm., which cross the other bands, uninterruptedly in some cases, for a distance of 4 cm. The apparent thickness of these bands is greatly exaggerated by the angle at which they are cut. Comparison of sections shows that while the other systems are cut at approximately right angles these broader bands are cut at an angle of 60° or 70°, which would seem to show that in reality they are no thicker than the others. Unfortunately our cut shows these bands but faintly.

Troilite seems to be pretty generally distributed through the mass but mostly in very small grains, although the cuttings revealed one nodule 0.75 inches in diameter and two others of about 0.5 inch each. The total amount of this mineral, however, is small, as might have been inferred from the specific gravity and the general smoothness of the surface.

I am indebted to Mr. Wirt Tassin, of the United States National Museum, for a chemical analysis of this iron and some notes on its structure, as follows:

The structure of the etched surface is octahedral. The three alloys, kamacite, tænite, and plessite, are present. The kamacite bands are of average length and the lamellæ vary in width from 0.5 to 1.5 mm. The tænite bands are of capillary size and are often irregular in trend and distribution. Occasionally the fairly uniform structure is interrupted by broad irregular bands which have a length about twice that of their width. Here and there are nodules of troilite, some of which inclose carboniferous matter. These troilite nodules are usually bounded by a thin line of schreibersite. The material available for analysis gave:

Fe	91.54
Ni	7.26
Co	.52
Cu	.03
Cr	.05
P	.12
S	.17
C	.004
Si	Trace
	99.694

The meteorite is distributed.

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WOOSTER.

Wayne County, Ohio.
Here also Wayne County, 1858.
Latitude 40° 50′ N., longitude 81° 58′ W.
Iron. Medium octahedrite (Om); Burlingtonite (type 17) of Meunier.
Found 1858; described 1864.
Weight, about 22.5 kgs. (50 lbs.).

This meteorite was first described by Smith[1] as follows:

The existence of a mass of meteoric iron from Wayne County, Ohio, has been known to me for some years; but I have delayed noticing its existence, hoping to obtain the mass, and thus give a more complete description of it than I am able to do.

My attention was first called to it by Prof. James C. Booth, of the United States Mint at Philadelphia, it having been brought to him by Peter Williams, of Wooster, Wayne County, Ohio, who supposed it to be a mass of silver or some other precious metal. Professor Booth saw at once that it was meteoric iron, and tried to procure it from Mr. Williams; but from some notion of its possessing considerable intrinsic value he retained it, and since that time both the iron and Mr. Williams have been lost sight of.

Professor Booth detached a small portion of it, part of which specimen he placed at my disposal, with the following memorandum: "Meteoric iron, given me in 1858 by Peter Williams, of Wooster, Wayne County, Ohio. It was a rounded mass, weighing about 50 pounds, and found by him in a woods near the above place while gathering bowlders to pave a town. It exhibits the usual figures on application of acid to a smooth surface."

As it is a well-authenticated meteorite, it is proper to make a record of it. Its specific gravity is 7.901, and it is composed of—

Iron	93.61
Nickel	6.01
Cobalt	.73
Copper, very minute, not estimated.	
Phosphorus	.13
	100.48

There was a very small quantity of manganese, that has been estimated along with the nickel.

Brezina [2] classed the meteorite with the Trenton group of the octahedrites with medium lamellæ. The group characters are:

Lamellæ straight, swollen, little grouped, with oriented sheen, neither hatched nor spotted. Fields abundant, combs likewise; plessite not much darker than kamacite.

Meunier [3] classed the meteorite as Burlingtonite. He states that even upon the small specimen of the collection acids show the tænite and braunite very neatly.

The whereabouts of the large mass of the meteorite do not seem to be known. Wülfing [4] records the distribution of only 49 grams.

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Wyoming. See Silver Crown.
Xiquipilco. See Toluca.

YANHUITLAN.

State of Oaxaca, Mexico.
Here also Oaxaca, Misteca in part, Goldbach's iron, and Teposcolula.
Latitude 17° 40′ N., longitude 97° 0′ W.
Iron. Fine octahedrite (Of) of Brezina.
Known 1804; described 1863.
Weight, 421 kgs. (926 lbs.).

As stated under Misteca, this mass has been much confused with it. Fletcher [8] decided that the two belonged to one fall. Owing, however, to differences in structure and composition, Brezina [10] separated the two, and his conclusion is generally concurred in.

The account of Yanhuitlan, given in 1840,[2] states that the mass was found by some Indian laborers while tilling the ground at the foot of a hill, called in the Mistec language Deque-Yucunino. The laborers transported the mass to the town, and it was used as an anvil for some years. In 1825 A. F. Morney, an Englishman, saw the mass and had a piece cut off, which he analyzed and found to contain iron, nickel, and silica. In 1864 it was removed to the City of Mexico, where it remains in large part in the National Museum, according to Castillo.[3]

According to the description of Rio de la Loza,[3] the shape of the mass is that of an irregular tetrahedron, or an inclined pyramid with three-sided base. Dimensions, 1.20 meters high and 0.65 meter thick.

Castillo [3] described the mass as of irregular shape, similar to a steep pyramid 0.65 meter high, four faces of which are large and uneven, two small and flat, and the edges of the pyramid irregularly truncated. The irregularities of the surface show different forms, some being pyramidal and some round or forming great hollows.

Rio de la Loza gives the following analysis:

Fe	96.58
Ni	1.83
Loss on ignition	.36
Calcareous earth	.60
Clay	.61
Siliceous earth, carbon, etc	.02
	100.00

Specific gravity, 7.82.

Rammelsberg [6] gives a partial analysis in which the nickel is reported as 6.21 per cent and the cobalt 0.27 per cent.

Cohen [11] gives the following analysis by Dr. O. Bürger:

Fe	Ni	Co	Cu	Cr	P	S	
91.87	7.36	0.65	0.02	0.01	0.09	0.02	=100.02

The structure of the etching figures is thus described by Brezina:[10]

Lamellæ of medium length, straight (except for mechanical deformation), bunched, well defined; kamacite strongly granular, tænite normal. Fields small, filled partly with kamacite-like and strongly granular and partly with dark-gray plessite. Width of the bands, 0.25 mm.

With Yanhuitlan, Brezina unites an iron obtained from Carl Goldbach, who acquired it from a collection where it had a label stating that it had been brought by Humboldt from Mexico from a meteorite used as an anvil.

Cohen [11] describes the etching figures as follows:

The strongly predominating lamellæ are of medium length, straight, and as a rule grouped. The kamacite is composed of grains measuring about 0.1 mm. in cross section, the boundaries of which are more sharply seen the more that they are magnified. Such magnification also shows partly reflecting, partly dull points which probably indicate a further structure of more minute grains. On strong etching the kamacite resolves into a clear, strongly reflecting groundmass in which black, dull particles 0.02 mm. in diameter, of rounded or elongated form lie now isolated, now arranged in parallel lines. Tænite is to be plainly seen only under the microscope so that with the naked eye the lamellæ can not be readily distinguished. The fields are abundant and uniformly distributed. They rarely exceed 1 sq. mm. in area and are filled as a rule by dark, compact plessite, easily yielding to acids. Glistening spangles can be seen in this under the microscope. These fields are plainly visible but others, commonly larger, can only be distinguished with difficulty. They are made up either of small complete lamellæ or of granular kamacite scarcely distinguishable from that of the bands. The plessite of this kind is attacked with more difficulty by acids than the first named. In the plate lying before me troilite appears only in small, compact, round to elongated nodules, which in a breadth of 4 mm. contain one to two daubréelite bands nearly 1 mm. broad and are not surrounded by swathing kamacite. Schreibersite I nowhere detected.

As stated, the meteorite is chiefly in the National Museum of Mexico. Ward, however, reports 16,380 grams in the Ward-Coonley collection.

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YORK.

York County, Nebraska.
Latitude 40° 45′ N., longitude 97° 30′ W.
Iron. Medium octahedrite (Om) of Brezina.
Found 1878; described 1898.
Weight, 835.2 grams (1.8 lbs.).

This meteorite was described by Barbour [1] as having been plowed up at the localityabove mentioned in 1878.

It is an iron showing Widmannstätten figures simply on burnishing and also upon etching. Its shape is discoidal with large shallow pits.

Analysis by Kunz [2] is as follows:

Fe	Ni	Co	
87.96	7.38	0.74	=96.08

The iron now forms a part of the Kunz collection in the American Museum of Natural History.

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Yorktown. See Tombannock Creek.

ZACATECAS.

Mexico.
Latitude 22° 47′ N., longitude 102° 32′ W.
Iron. Zacatecas group of brecciated octahedrites (Obz) of Brezina; Caillite (type 18) of Meunier.
First mentioned in 1792.
Weight, 780 kgs. (1,716 lbs.).

This meteorite seems to have been first mentioned in the Gazetas de Mexico [1] in 1792, as follows:

From time immemorial there has been in the old St. Domingo Street of the city of Zacatecas a stone, half buried in the ground, which has been called iron stone by reason of its solidity. As to its origin there is only an oral tradition that it was found by one of the first colonists when working the Quebradilla mine and has been lying near the door of his house ever since. It was noticed there by Sonneschmid, recognized by him as native iron, and recommended to the attention of the Government. Don Fermin Apecechea had it taken to his house and weighed; the weight was ound to be 2,000 pounds. The mass is somewhat more than 1.5 yards long, not so much in breadth, and somewhat over a quarter of a yard in thickness.

The mention by Sonneschmid [2] the present compiler has not been able to consult.
Humboldt [3] merely quotes Sonneschmid's information, as does also Chladni.[4]
Burkart [5] saw the Zacatecas meteorite in 1825 and described it as follows:

This iron is 4.5 feet in length, 1 foot 9 inches wide, and of an average thickness of 9 inches. The specific gravity is 7.5 and the entire mass considerably heavier than it was estimated by Sonneschmid, who fixed its weight at 2,000 pounds. Its form is quite irregular, although without prominent angles or sharp edges. The exterior is tolerably smooth, but it has considerable pittings and is marked by many cracks and crevices. The iron of the mass is malleable, ductile, and consequently only slightly disruptable. It seems to contain many isolated particles; at all events the polished surface shows rounded and jagged specks, which form a streak of a metallic luster, shading to yellow. The fracture is granular and jagged; several veins are noticeable in a few places. The color of the metal is pale steel gray, approximating silver white on the one hand, and, on the other, dark steel gray. Etching produces only weak and irregular Widmannstätten figures.

Partsch [6] described a section in the Vienna collection as follows:

Compact native iron with a quite unusual quantity of pyrrhotite (and also some pyrites) distributed through the whole mass, chiefly in round or lens-shaped nodules. The large polished piece in the possession of Reichenbach, brought by Burkart to Europe, shows the sulphide so distributed in the iron that it forms an incomplete network. The above suggestion that the sulphide may be of twofold origin comes from the fact that two colors and two specific gravities may be distinguished. The iron shows zigzag clefts and on well-polished surfaces furrowed lines are visible which run in different directions. No true Widmannstätten figures formed on etching, but the already mentioned lines are straight and commonly lie near together. The rectangular fields between paths of lines are filled with points and fine striæ. These are seldom parallel but run in various directions and often radially. This is on the whole a highly characteristic and remarkable iron and is difficult to describe.

In 1849 Bergemann [7] made a study of some borings of Zacatecas, brought to him by Burkart, as follows:

Although the meteoric iron from Zacatecas has been already repeatedly described, an analysis of the same is still wanting. At the request of Dr. Burkart I therefore undertook to make such an analysis, the more willingly because I had obtained through his kindness a sufficient quantity of the borings produced in the cutting of several large pieces of the iron in Zacatecas.

Specks of a yellowish-gray color, measuring one-half to one line in diameter, occur in this iron, which appear to consist of magnetic pyrites. Five or six of them may be counted upon a section surface 1.5 to 2 inches in size. According to Partsch, however, the specimens of the Vienna collection and especially a large piece of the famous Reichenbach collection contain, besides magnetic pyrites, possibly also pyrites, both scattered through the meteoric iron like a network, and this interspersed sulphur compound is regarded as the reason why the Widmannstätten figures can

scarcely be produced at all upon this meteorite. Nevertheless, according to what I had opportunity to see of them, so general a distribution of the iron sulphide seems improbable and I accordingly regarded the outcrop as magnetic pyrites exclusively.

The borings to be used for the analysis were quite thin and much rusted; the other particles clinging to these gave no indication of their character. The borings were carefully cleansed with weak sulphuric acid, washed, and dried by the boiling heat of the water.

The mean of three determinations of the specific gravity gave 7.4891, which agrees fairly well with the figures given by Burkart and Rumler.

The iron was not completely dissolved by acid. The residue, insoluble in hydrochloric acid, after three weighings made in the course of the qualitative analysis, amounted to a mean of 3.78 per cent.

In the decomposition of the iron there was developed, along with the hydrogen gas, a carbon compound of the same, and the carbon in this was accordingly determined separately. The combustion method of Regnault or Bromeis was not adapted to this case, since it would be impossible to reduce the iron to so fine a powder as would be necessary in order to obtain an exact result, without running the risk of contaminating the meteoric iron with particles of the pulverizing tools.

The analysis gave the following:

Fe	85.094
Ni	9.895
Co	.668
Cu	.030
Mg	.187
C	.164
C (Fe)	.334
X (=schreibersite)	1.649
Y (=chromite)	1.482
S	9.845
	100.348

The phosphoric metal consists of:

	Per cent.
Iron and nickel	1.103
Phosphorus	.546

The principal constituents of this meteoric iron are, accordingly, iron and nickel, and approximately 9 atoms of iron to 1 atom of nickel, a ratio such as Rammelsberg found in the magnetic portion of the meteoric stone from Klein-Wenden and such as seems to recur generally in the case of most meteoric irons. So great a percentage of iron sulphide as the above figures of Partsch assumes for this mass is certainly not indicated by the present analysis, the results of which, however, correspond fully with the exterior characteristics of those specimens which I had opportunity to see. Magnetic pyrites occur isolated only in a few places and even large fragments of the borings may be dissolved without developing even a trace of hydrogen sulphide, while it is often visibly present in other small particles. If the mass of the sulphur compound be estimated according to the quantity of sulphur and if the composition of the magnetic pyrites, according to Frankenheim, be assumed as FeS, this will correspond with 2.269 per cent of magnetic pyrites, and, therefore, there remains 83.21 per cent of iron combined with nickel.

The meteorite consists of:

Nickel iron	93.77
Magnetic pyrites	2.27
Chrome iron	1.48
Schreibersite	1.65
Carbon	.49
	99.66

This meteorite, in respect of its iron content, stands quite near to the meteoric iron of Elbogen, but it contains a much greater quantity of foreign ingredients—almost 6 per cent—whereby the production of the Widmannstätten figures must be made considerably more difficult.

Nöggerath [8] mentioned the production of Widmannstätten figures on the mass as follows:

The figures were brought out by etching; the specimens also showed surfaces upon which certain figures were produced by tarnishing, such as usually occur in the case of steel. The specimens were derived from two different iron masses, both from Mexico, the one from Zacatecas and the other from the neighborhood of Toluca. Both masses, in the produced Widmannstätten figures, show very markedly the peculiar character of meteoric iron; although the markings upon the Toluca mass are finer than those of Zacatecas. The specimens belong to the academic mineral collection at Bonn; Sprecher first permitted their preparation anew in the prescribed manner.

Bergemann [9] made a further examination of the Zacatecas iron in 1857, as follows:

I obtained from Burkart a fragment of the Zacatecas meteorite, which I had already examined for the purpose of repeating the analysis. This seemed desirable since Manross had published the results of the analysis of a meteoric iron of unknown locality, which possessed an external resemblance to that of Zacatecas, and even the etched surface

showed much similarity with that of Zacatecas. It appeared possible to Burkart to assume that both aerolites originated from one fall. I think, however, that there is much against this assumption. In the meteorite of unknown locality, which was examined by Wöhler and analyzed by Manross, granules of olivine and a granule of an apple-green mineral were found. I found nothing of this sort in the Zacatecas iron, and while even the results of the analyses of aerolites from one and the same find do not agree entirely, still the quantity of the individual constituents differ so much in this case that it is not possible to assume that they are all from one fall.

In the repetition of the investigation of the Zacatecas iron I found no terrestrial mineral. The insoluble residue remaining after treatment with dilute muriatic acid was tested with the microscope at 200 diameters, but it appeared entirely homogenous. It might be assumed that the small olivine particles were decomposed by the action of the muriatic acid, since the iron solution contained a small quantity of magnesia; in that case, however, the presence of silicic acid would also become apparent, but this was not found, and besides only dilute muriatic acid was used for dissolving and the action of this was assisted only by slightly warming.

In the determination of the essential constituents of this meteoric iron I obtained such a close approximation to my own former results and such a wide divergence from Manross's published results, that I could not suppose that the iron examined by the latter belonged to Zacatecas.

The second analysis gave:

Fe	85.42
Ni	9.73
Co	.44
Schreibersite	1.05
	96.64

Müller [10] gave a description and analysis of a piece of the iron as follows:

I made an examination of a specimen which was brought some years previous from Zacatecas, passing from M. F. D'Arcais, a mining director of that region, to Mr. Brice Wright, of London, in order to determine whether it was identical with a former acquisition from that country or whether it should be considered as a new one.

The piece from which the material for the examination was taken was of irregular shape and was evidently a projection cut from a larger mass. It weighed about 20 ounces and those sides which from their black crust evidently formed part of the exterior of the original were irregularly impressed and rounded at the edges.

The iron is soft, tough, and difficult to break. The fractured surface shows a highly developed laminated structure. The polished surface contains irregular and circular spots, which are metallic and of a dark bronze color; when it is tarnished or etched there appear bright points, which are generally arranged in lines, intersecting each other in various directions. An oblique and intense illumination shows the intermixture of this bright substance throughout the mass of the iron.

The etched surface does not exhibit any Widmannstätten figures like the iron from Xiquipilco, Durango, and others from Mexico, but presents the crystalline appearance of tinned iron when subjected to the action of an acid (moiré metallique), resembling in this respect the iron formerly brought from Zacatecas and analyzed by Bergmann.

The iron is not passive and is dissolved with facility, even in diluted hydrochloric acid, when slightly warmed, leaving a small insoluble residue which, however, dissolves entirely in aqua regia.

The dark bronze-colored nodules embedded in the iron likewise dissolve with great ease in dilute acids, with evolution of sulphuretted hydrogen, and behave in every respect like monosulphide of iron.

Three analyses yielded the following results:

	I.	II.	III.
Fe	89.84	91.30	90.91
Ni	5.96	5.82	5.65
Co	0.62	0.41	0.42
P	.....	0.25	0.23
S	0.13	.....	0.07
Si	.....	.....	0.50
C	trace.	trace.	trace.
Mg	trace.	trace.	trace.
Insoluble	3.08	2.19	2.72
	99.63	99.97	100.50

The insoluble residue after treatment with dilute hydrochloric acid was further analyzed, with the following results:

Fe	75.02
Ni	14.52
P	10.23
	99.77

This analysis furnishes an additional proof that the substance termed schreibersite, and which forms a characteristic component of almost every meteoric iron, is of very variable composition; the quantities of iron, nickel, and phosphorus which are the principal constituents, differ very materially in the schreibersite of different kinds of meteoric iron.

The hydrogen was tested for carburetted hydrogen but none was found. Neither arsenic, manganese, nor chromium was found in this meteoric iron, and none of the minerals which are insoluble in acids and which are sometimes met with in meteoric iron were detected in this specimen.

The above examination shows that this specimen is different from that of the former meteorite from the same locality. Even allowing for a discrepancy in the quantities of the constituents which might vary with the irregularity in which the schreibersite, insoluble sulphides, and sulphate of iron are distributed in the nickeliferous iron, the entire absence of carbon or graphite and chromic iron which, according to Bergmann, amount to 0.49 for carbon and 1.48 for chromic iron, can not be considered accidental.

Rose [11] described a specimen in the Berlin collection as follows:

This is an iron of very characteristic structure which can only be seen in a large piece. Besides many small pieces the Berlin Museum possesses an almost rectangular piece 1 inch thick, 3 inches broad and 3.5 inches long, cut from a larger piece which was brought by Burkart from Mexico. Sides of the plate are in part formed by natural surfaces. On an etched surface one sees that this iron consists of coarse granular pieces which are about 1 inch in diameter and irregularly bounded, and that these consist of pieces lying parallel to the faces of the octahedron as in the iron meteorites which give Widmannstätten figures. The component pieces are not very regularly bounded but their direction is straight as one can see from the included schreibersite, which also shows, on cut surfaces, connected fine striæ. Under the microscope, however, one sees that these striæ consist of single pieces which lie beside one another in one or more rows, or in single pieces in part regularly banded and lying in parallel position. They are thus incomplete crystals. Included crystals of rhabdite do not occur, though the schreibersite in many pieces is so abundant and fine that one could easily mistake the two. In certain lights one also sees a part of the component pieces shining, another part not, though the latter shine if the lighting is different. Troilite is abundant in small irregular particles and is distinguished by its dark color. It has a thin coating of metallic luster which can not be distinguished from schreibersite; also small particles of graphite within it. On the natural surface two round furrowed impressions occur which Reichenbach considers to have been produced by the weathering out of troilite.

Rose also gives a drawing of an etched section of Zacatecas and of schreibersite crystals found in it.

Cavaroz [12] gave the following note regarding the meteorite:

In the same hacienda (Zacatecas) there is also a block of iron discovered a long time ago at Zacatecas. A small portion of it was with great difficulty cut off to be carried to England for examination. The block which remains may be 70 cm. in length, 30 in width, by 25 in thickness. It is irregularly rectangular in form. The upper surface is indented with small rounded cups. The nature of the ground upon which this block was found and with which it had no relation, and the peculiar quality of malleability belonging to this iron, create the presumption that the mass is of meteoric origin.

Reichenbach [13] makes frequent mention of Zacatecas, the most important of his observations being as follows:

It has a hard slaglike crust which scratches glass easily and takes a fine polish. It is embedded in the angles of the exterior surface and if present with the iron upon a polished section it is readily recognized by the fact that upon etching the iron is more or less attacked all over, but the slag patches, somewhat reddish black in color, retain their glassy luster unchanged.

* * * * * * * * *

It is grouped in class 9, group 1. This class includes all iron meteorites without Widmannstätten figures. * * * The first group, in which Caryfort and Zacatecas are included, is not without certain marks which correspond in a measure to Widmannstätten figures, but in a different and undeveloped way, and distorted on account of the intermingling with much pyrites.

* * * * * * * * *

Others again (of the iron meteorites) show an entirely crystalline structure of a peculiar and distinct variety which we never meet with upon nonmeteoric metal, such as * * * Zacatecas, * * * etc.

* * * * * * * * *

We consider next the fine Zacatecas meteorite which Burkart brought with him from Mexico. It consists of a composition of many iron fragments the size of walnuts. But these fragments are seeded with numerous roundish, elongated, and sometimes vermiform particles of pyrites from the size of hempseed to that of small peas. All are rounded, nowhere jagged, and incompletely inclosed in the iron. * * * The magnetic pyrites is the older; the iron is, moreover, the younger member of the compound.

* * * * * * * * *

Zacatecas shows the Widmannstätten figures upon the raw fracture without the labor of polishing or etching.

* * * * * * * * *

If one would see a meteorite in which the swollen appearance as well as the grouping of the kamacite is especially well developed he must turn to Zacatecas. There he will see the abundant inclusions of magnetic pyrites everywhere enveloped in kamacite, arranged in every direction, and the outer surface of the kamacite diverted by pyrite, shaped in all possible swellings and bendings. A large piece of Zacatecas weighing some 12 pounds, in my collection, which

I had cut in 5 parts by 3 incisions in different directions, and etched in different degrees, yielded figures which I regard as an example of well-developed kamacite formed in both directions indicated (either crumpled or straight).

* * * * * * * * *

Zacatecas belongs with meteoric iron of the Triassic system, in which no combs have been observed.

* * * * * * * * *

Zacatecas exhibits an especially well marked case of the inclusion of iron sulphide in an envelope of puffy kamacite, surrounded by the usual trias of which the meteorite is mainly composed. Zacatecas has no regular Widmannstätten figures, but a crystalline structure which approaches very near to it.

* * * * * * * * *

Zacatecas contains many scattered particles with a whitish luster which often run into short rows.

* * * * * * * * *

In Zacatecas the magnetic pyrites are entirely enclosed with Glanzeisen (Lamprite).

* * * * * * * * *

The metallic luster shows very distinctly in Zacatecas.

* * * * * * * * *

In my specimen of Zacatecas iron sulphide occurs in small nodules of from 6 to 3 lines in diameter with a bronze-colored appearance resembling gun metal, sometimes polished and sometimes with dull unburnished appearance.

* * * * * * * * *

The iron sulphide in Zacatecas assumes the vermiform shape.

* * * * * * * * *

The cones (of schreibersite) or the tubular molds of the same occur in Zacatecas upon a specimen in the Berlin University collection, but in comparatively smaller forms about the thickness of a pen quill. Zacatecas contains, also, larger and smaller fragments of roundish, bronze-colored iron sulphide embedded in it.

* * * * * * * * *

Zacatecas affords a fine example of the occurence of iron glass. In the middle of a fragment of this meteorite there appears upon the weakly etched section surface a black, brightly glistening circle, somewhat elongated, which consists of iron glass. It has a narrow canal from below outward, through which it filled from the outside.

* * * * * * * * *

A specimen of Zacatecas in my collection shows more or less pronounced fissures where the iron is sundered.

Burkart [14] discussed the locality from whence Zacatecas may have come, as follows:

Unfortunately the locality (hacienda) at which Cavaroz made a long halt, before his arrival at Zacatecas, is not indicated by name, nor is it even mentioned from which side of Zacatecas it is reached. Cavaroz mentions the occurrence of fossil remains of mammals not far from Cuquio. This is a little town (Lat. 21° 40′ N.) 15 leagues northeast from Guadalajara, in the State of Jalisco, in which such remains are found at different points. May we conclude from this that it is reached from Cuquio to the latter (hacienda) and then from this hacienda farther northward toward Zacatecas, or is it reached, with the French troops from Mexico, by another road to Zacatecas? In both cases, the hacienda in question would be south of Zacatecas. Yet this determines nothing concerning the place of discovery of the meteorite in question, since there are many fine haciendas in the extensive environs of Zacatecas. The iron is said to have been brought a long time ago from Zacatecas to its new locality; but it is not mentioned where it was found there, and still Cavaroz concludes from the character of the ground in the locality that it was meteoric (and not terrestrial) iron.

In Zacatecas, where I lived for a long time and which I frequently visited, I heard nothing about any second piece of meteoric iron having been in existence there at an earlier date. According to very uncertain data, the specimen which belonged there is said to have come thither from the north, then to have lain at the neighboring mine—Guebradilla—and from thence to have been brought into the city. I had received no information from England in regard to the examination there of any meteoric iron from a hacienda in the neighborhood of Zacatecas. Consequently, Doctor Cavaroz himself, or else some one of his companions of the French army in Mexico, may be able to give more exact information concerning the locality in question, than this Daubrée, who has obtained a great reputation in this field, because of his investigation of different meteorites, may be in a position to obtain.

Brezina,[15] in 1885, placed Zacatecas in a group by itself as a brecciated octahedrite. The characteristics of this group he defined as follows:

Walnut-sized parts, each showing octahedral structure, with numerous large troilite nodules 2 to 3 mm. penetrated by small, often to large, troilite plates.

Castillo [16] states that the Zacatecas meteorite—

was originally found in the Rue Royale, of the city of Zacatecas, and was moved to the hacienda of Cieneguillas, the property of the Gordoa family. It has the form of a parallelopipedon 1.06 m. in length, 0.5 m. in width, and 0.25 m. in height or thickness. Its volume is 132 cu. dm., and its density 7.7, giving a weight of 1,000 kg.

Fletcher [17] remarks that the piece of Zacatecas referred to by Cavaroz [12] as having been taken to England for study is probably the one weighing 20 pounds, which was described and analyzed by Müller in 1859.

Meunier [18] grouped Zacatecas as an appendix to Caillite, and made the following observations:

In small specimens Zacatecas is without doubt a Caillite, the museum having a specimen which shows this very neatly. But on other pieces, especially if large, one sees that the mass results from the union of numerous intimately grouped elements which resemble a species of breccia. This character, certainly of great geogenic importance, would perhaps justify the creation of a special type for Zacatecas, but at present we are not reduced to this extremity.

Brezina,[19] in 1895, gave a plate showing the appearance of a section of Zacatecas. He states that the troilite laths are rare and the troilite nodules irregular through union with plates and lenses of the same substance. With Zacatecas he groups Barranca Blanca.

Cohen [20] found Zacatecas capable of acquiring a weak permanent magnetism.

Later,[21] he made a detailed study of the structure and composition of a section of the mass, as follows:

A piece weighing 92+ grams, after removing all visible troilite, was dissolved in 55 days with strong evolution of hydrogen sulphide, in one part HCl+20aq. It dissolved more easily than any meteoric iron which I have hith erto investigated. Action of the acid was also very uniform, the surface of the plate remaining relatively smooth, instead of forming cavities in the process of solution as usual. From time to time large pieces broke away in consequence of the coarse granular structure. The small remaining angular pieces, as usual, were very slowly attacked. After removing these, also schreibersite, taenite, and little troilite nodules, there remained a not further separable residue of 1.68 grams. Investigation of the latter gave the following result (I):

	I	II
Fe	10.22	7.11
Ni	46.82	37.47
Co	.70	
Cu	.81	2.84
Cr	.30	trace
P	8.96	0.88
S	4.67	.....
C	1.86	5.60
CaO	.16	.....
MgO	.12	.....
Res	2.43	19.95
	77.05	73.85

The 23 per cent lacking may be ascribed to water and oxygen, which were probably taken up during the long treatment of the piece with acid. The residue insoluble in aqua regia appeared to be chromite with transparent, colorless, doubly refracting grains showing a broad border in Canada balsam. It often contained opaque inclusions. Since, in addition to these, turbid, flaky particles were seen, silicates decomposable by acids may be present in small quantity. The character of the residue of 1.68 grams is difficult to determine, owing to its high content of nickel and copper and low content of iron. If chromium is reckoned as daubréelite and sulphur as troilite, there remains after deducting CaO, MgO, and Cu, 8.96 P, 2.55 Fe, and 47.51 Ni+Co, which corresponds to an iron-nickel phosphide poor in iron or an almost pure nickel phosphide. This has not hitherto been known, and is less to be expected in Zacatecas, since the isolated schreibersite is especially poor in nickel. It may here be noted that the residue obtained by Derby from Canyon Diablo, which was likewise distinguished by its high content of nickel and copper and low content of iron, contained much less phosphorus. Derby's result is shown above under II. Evidently, this portion of Zacatecas should be further investigated, and it would be also desirable to learn in what form the copper is present, since it is very probable that in many iron meteorites there occurs an unknown copper-rich ingredient. Assuming the above calculation of daubréelite and troilite to be correct, the total result of disintegration of the meteorite is as follows:

	Grams	Per cent
Soluble nickel-iron	87.1426	94.47
Angular pieces	0.3703	0.40
Taenite	0.1554	0.17
Schreibersite	2.8258	3.06
Troilite	0.2356	0.26
Daubréelite	0.0140	0.02
Nickel phosphide ?	0.9948	1.08
Carbon	0.0312	0.03
Chromite and silicate grains	0.0693	0.07
Undetermined residue rich in copper	0.4056	0.44
	92.2446	100

Schreibersite occurs as small plates, grains, and flakes. Larger crystals do not seem to have been present in the plate investigated, but it may be that they were destroyed in the process of solution. The result of analysis of the schreibersite by Scherer follows under III. IIIa gives the composition calculated to 100 after removal of the chromium reckoned as daubréelite and the chromite contained in the insoluble residue. The older analysis of Müller is given (IV) for comparison.

	III	IIIa	IV
Substance taken	0.5375 gr.		0.5245 gr.
P	15.12	16.10	10.23
Fe	68.37	72.62	75.02
Ni	10.07	10.72	14.52
Co	0.52	0.56	.....
Cr	0.32	.....	.....
S (calc.)	0.39	.....	.....
Chromite	4.60	.....	.....
	99.39	100.00	99.77

From IIIa: Fe : Ni (Co) : P=2.4992 : 0.3702 : 1
Fe+Ni (Co) : P=2.869 : 1

The chromite occurs as highly lustrous grains with conchoidal fracture. It gave qualitative tests for iron, chromium, aluminum, and magnesium. The taenite occurs in relatively small plates which were not obtained in sufficient quantity for analysis. An analysis which I made of the solution gave the following results after deduction of daubréelite (0.05 per cent) and schreibersite (0.69 per cent):

Substance taken	0.8703 gr.
Fe	94.15
Ni	5.18
Co	0.61
Cu	0.017
Cr	0.023
P	0.113
	100.093

From this the total mineralogical composition would be as follows:

Nickel-iron	94.34
Schreibersite	3.54
Troilite	.26
Daubréelite	.10
Chromite and silicate	.21
Carbon	.03
Nickel phosphide ?	1.08
Undetermined residue	.44
	100

As the above would not give the total composition on account of the lack of taenite, a mass analysis was made by Scherer. The material employed for the analysis was cut from the plate previously mentioned. Scherer's analyses follow under VI and VII. VIII gives the mean and VIIIa the analysis calculated to 100, after the deduction of 6.34 per cent of schreibersite and 0.41 per cent of daubréelite. The latter was calculated from the sulphur. Whether the sulphur, as determined, is too low or whether the chromium may be present in some other soluble combination could not be ascertained owing to lack of material. The total content of chromium reckoned as daubréelite, which amounts to 2.4 per cent, is doubtless too high; also the calculation of the total phosphorus as schreibersite is, according to the investigation of the nonmagnetic residue, of doubtful accuracy. Zacatecas seems to contain components which have not been hitherto recognized in iron meteorites, and investigation should therefore be carried on with more abundant material.

The results given under VIIIa show nearly the composition of the nickel-iron. They also show that of the older analyses only those by Müller apply to the meteoric iron now generally recognized as that of Zacatecas.

The analyses by Bergemann probably were made on another meteoric iron. He stated that he obtained his material from Burkart, but either a different iron must have been found near Zacatecas or some exchange of pieces took place. This is the more probable since the percentages of nickel plus cobalt in his two analyses agree so well. Of course, it is not impossible that different pieces of one iron meteorite may show such variation of chemical composition, but it is hardly likely.

	VI	VII	VIII	VIIIa
Substance taken	0.7043 gr.	0.7681 gr.		
Fe	92.09	....	92.09	92.82
Ni	5.89	6.98	5.98	5.63
Co	.91		.91	.92
Cr	.68	.80	.74	.63
P	1.02	....	1.02	....
S	.....	.18	.18	....
Insoluble	.04	....	.04	....
	100.63		100.96	100.00

The meteorite is at present preserved almost entire in the museum of the School of Mines, City of Mexico. In addition, about 24 kgs. are reported by Wülfing in collections, the University of Tübingen possessing 5,128 grams, the British Museum 3,847 grams, and the University of Bonn 3,436 grams.

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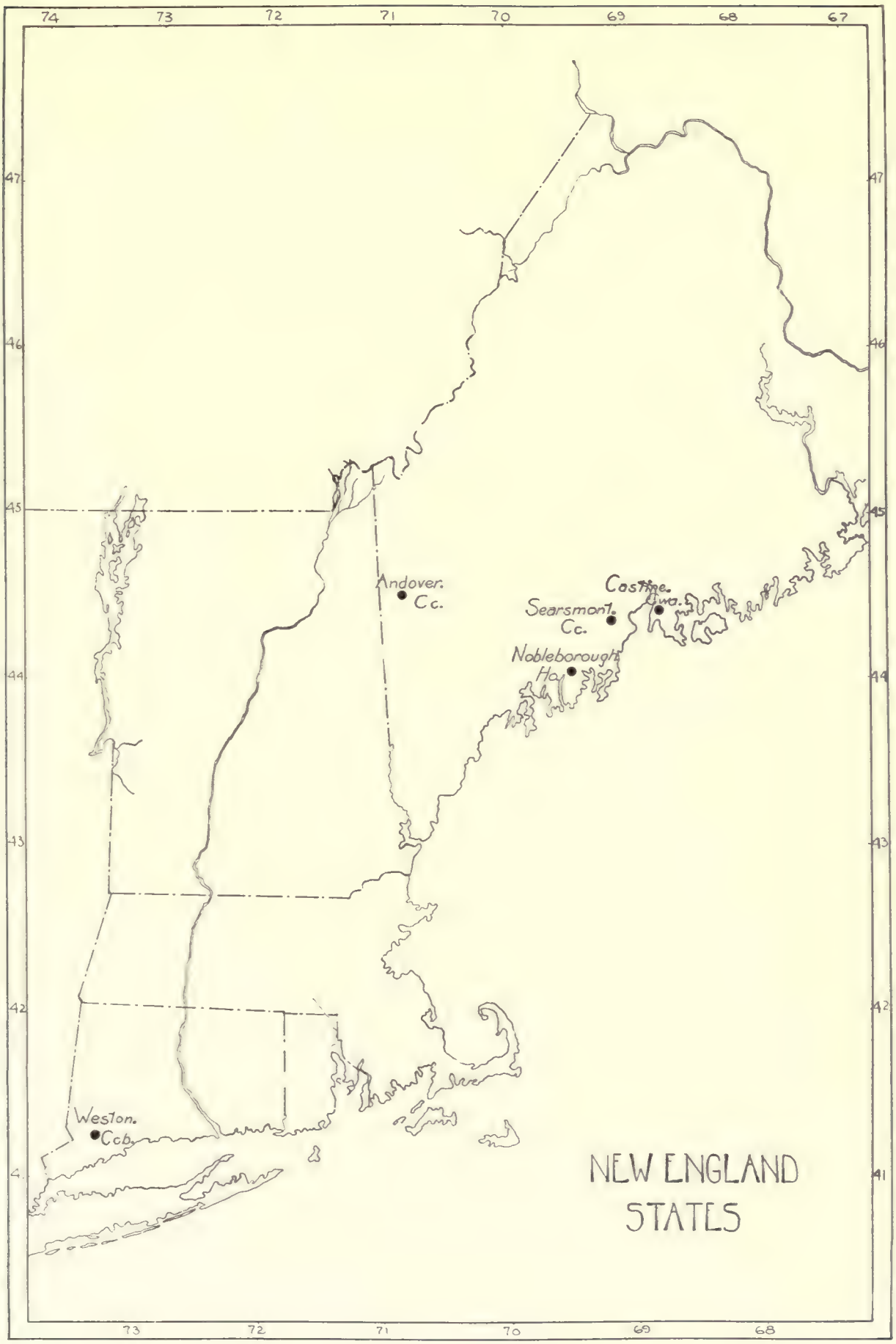
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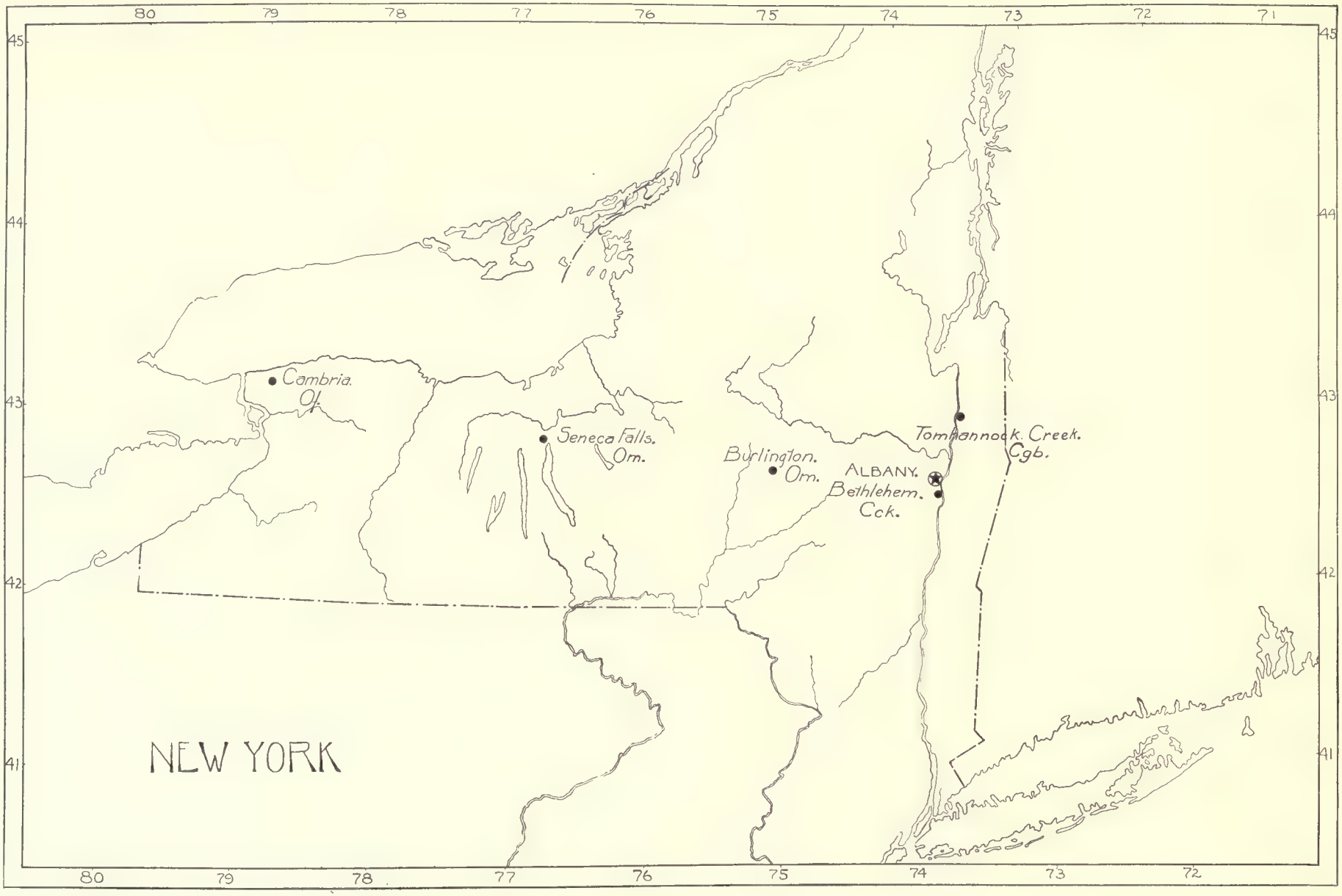
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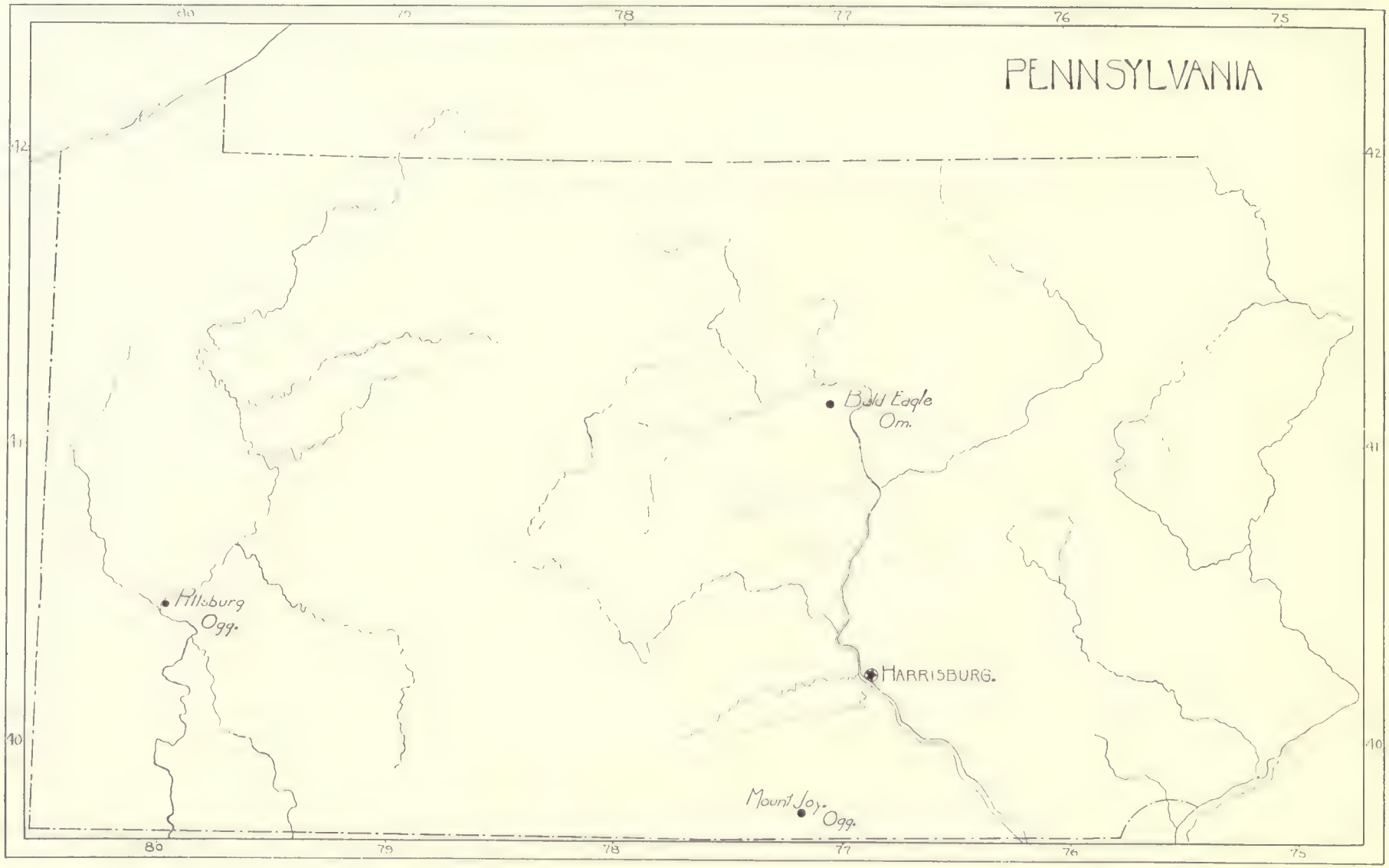
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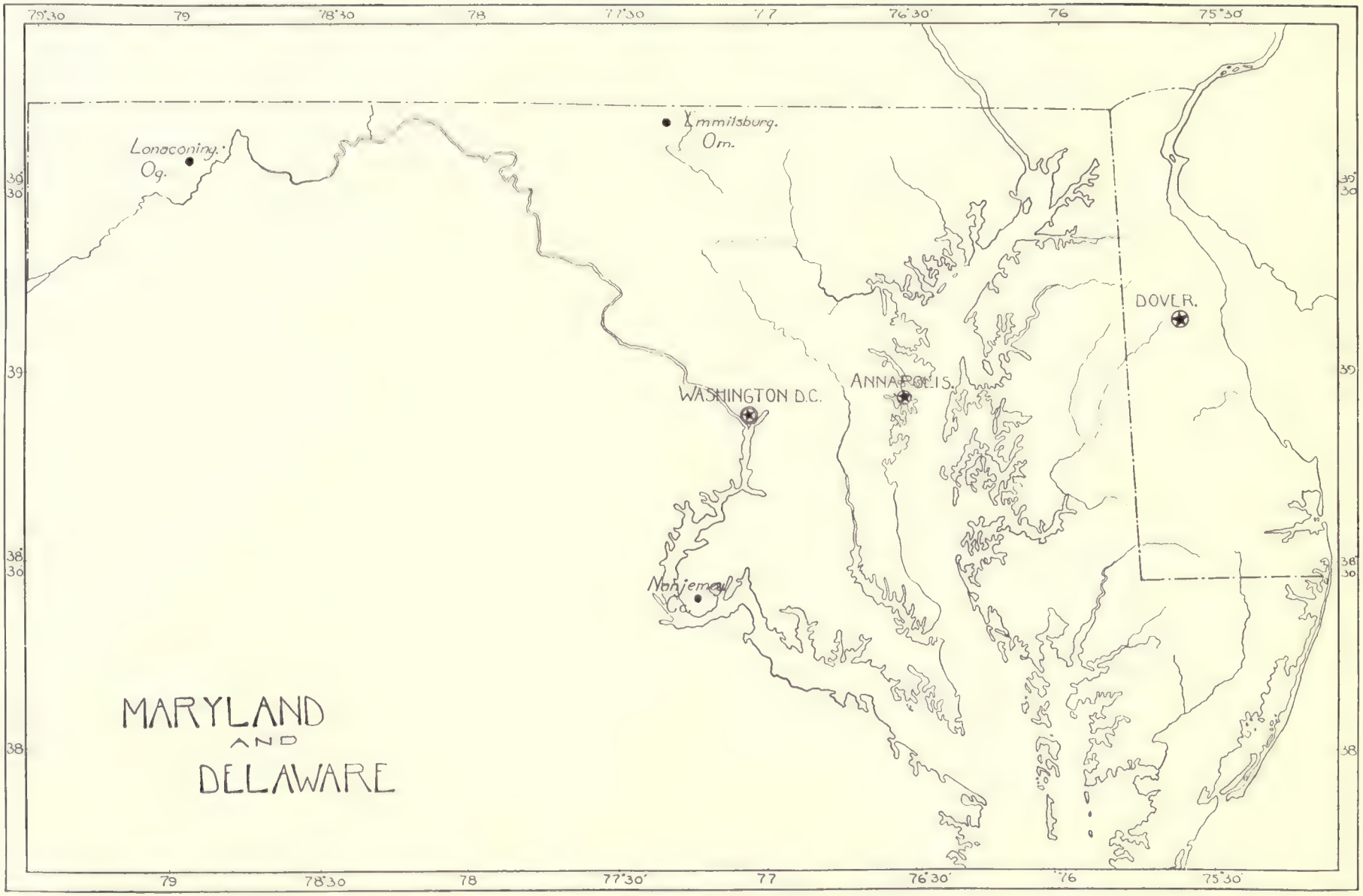
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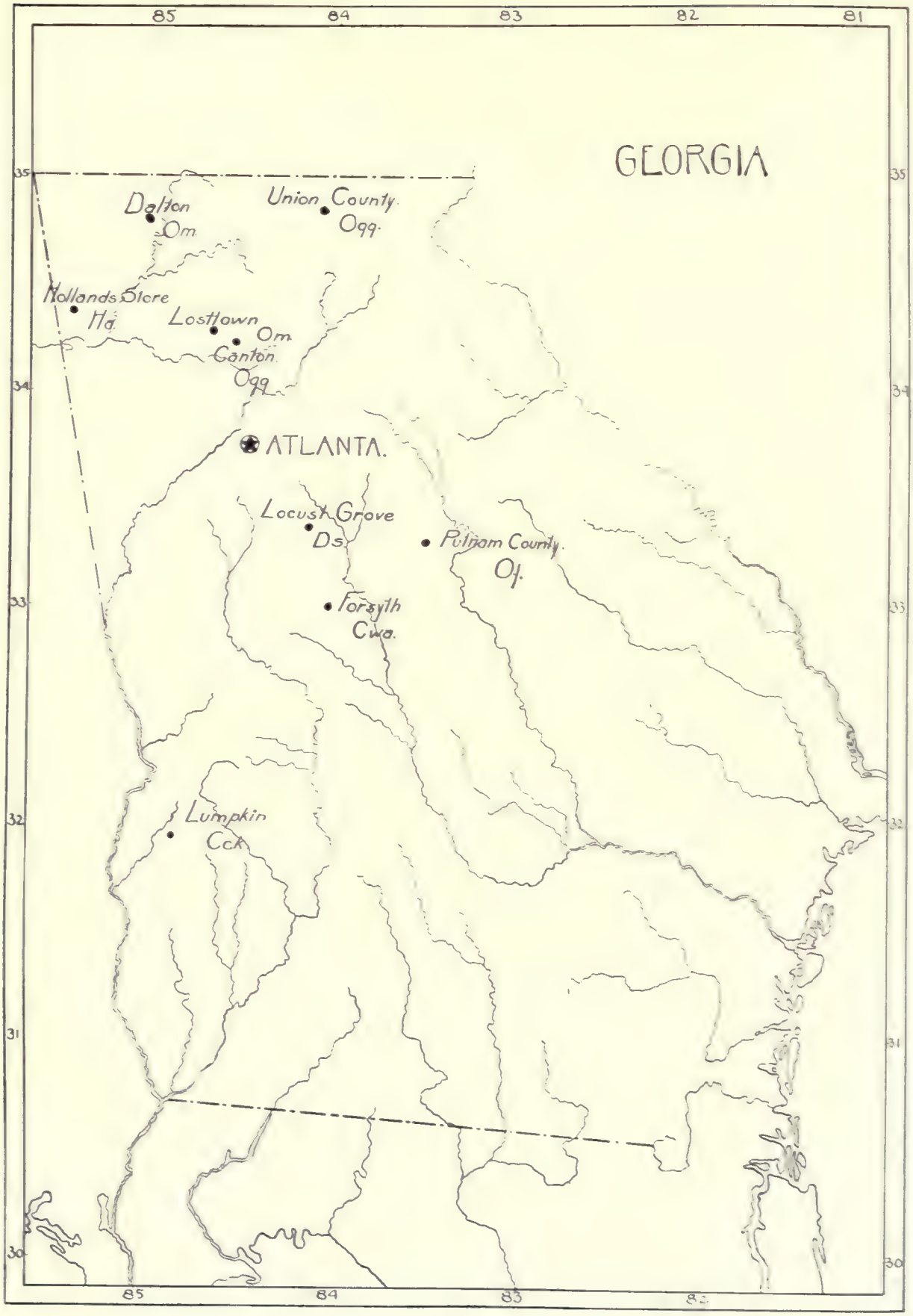
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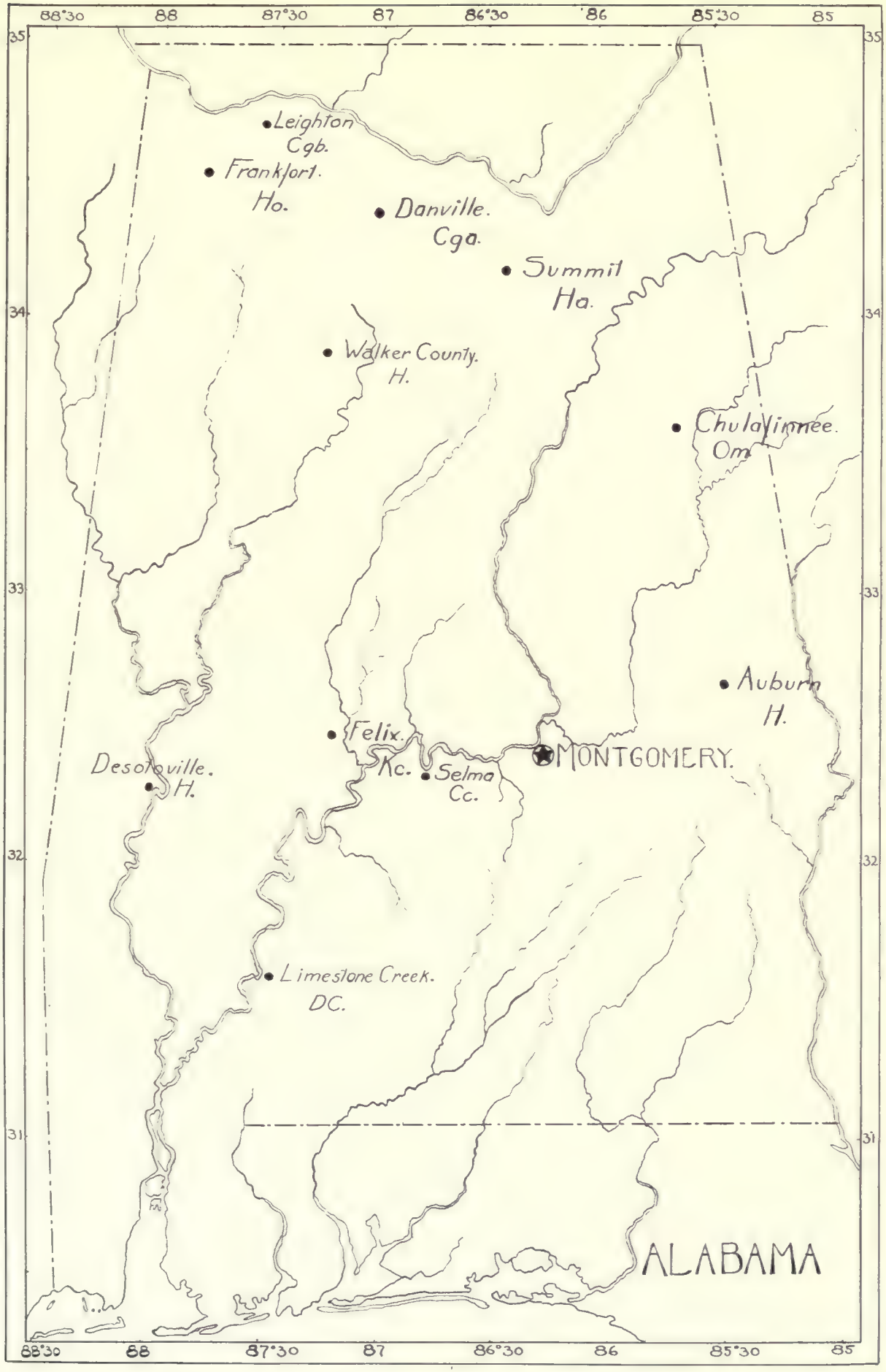
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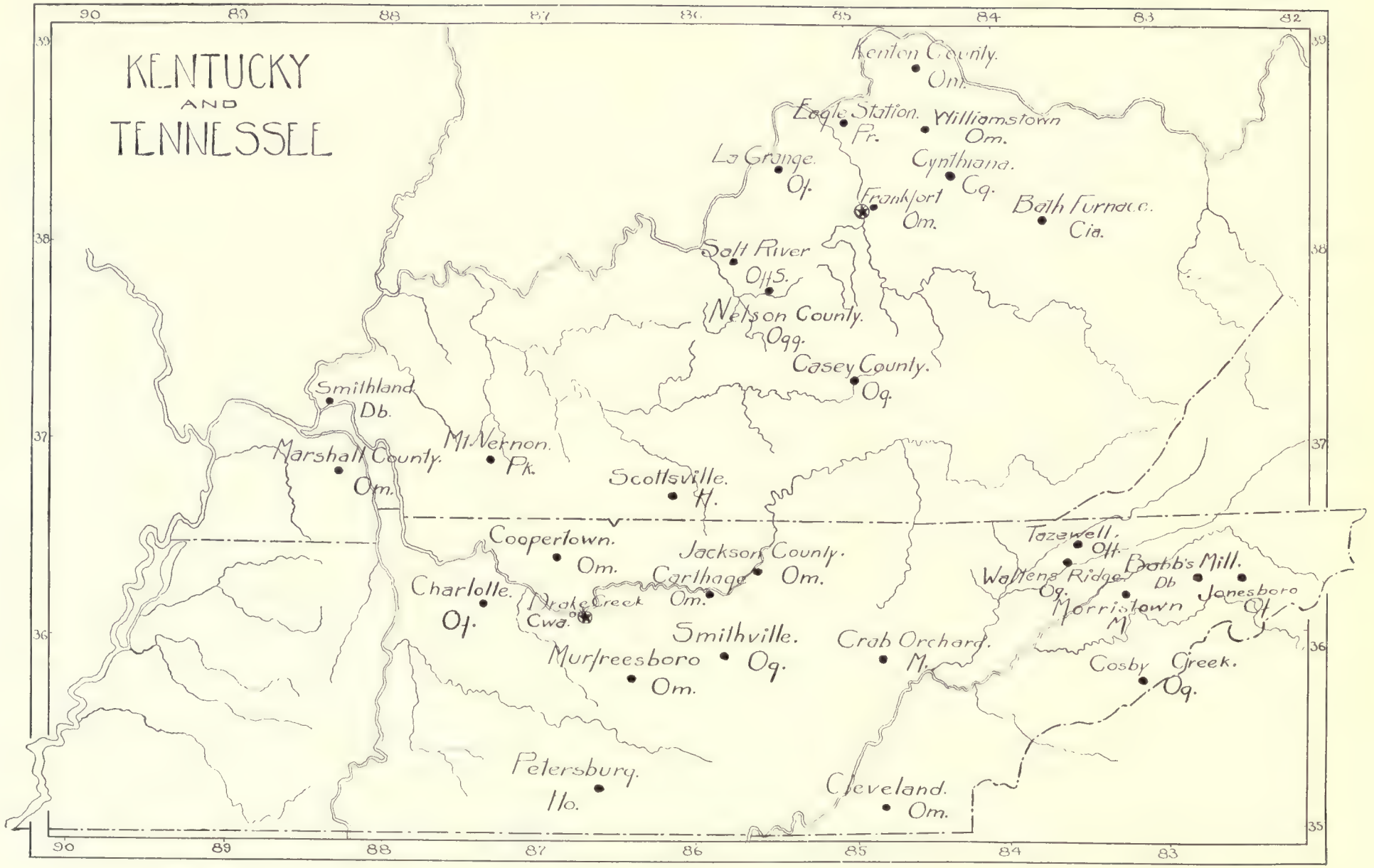
H.
Limestone Creek.
DC.
ALABAMA


KENTUCKY
AND
TENNESSEE
Kenton County.
Om.
Eagle Station.
Pr.
Williamstown
Om.
La Grange.
Of.
Cynthiana.
Cq.
Frankfort
Om.
Bath Furnace.
Cia.
Salt River
Of S.
Nelson County.
Oqq.
Casey County.
Oq.
Smithland
Db.
Mt. Vernon.
Pk.
Marshall County.
Om.
Scottsville.
H.
Cooperlown.
Om.
Jackson County.
Carthage
Om.
Charlotte.
Of.
Drake Creek
Cwa.
Om.
Smithville.
Oq.
Murfreesboro
Om.
Crab Orchard.
M.
Tazewell.
Of.
Bobb's Mill.
Db
Waltens Ridge
Oq.
Morristown
M.
Jonesboro
Of.
Cosby Creek.
Oq.
Petersburg.
Ho.
Cleveland.
Om.
90
89
88
87
86
85
84
83
82
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36
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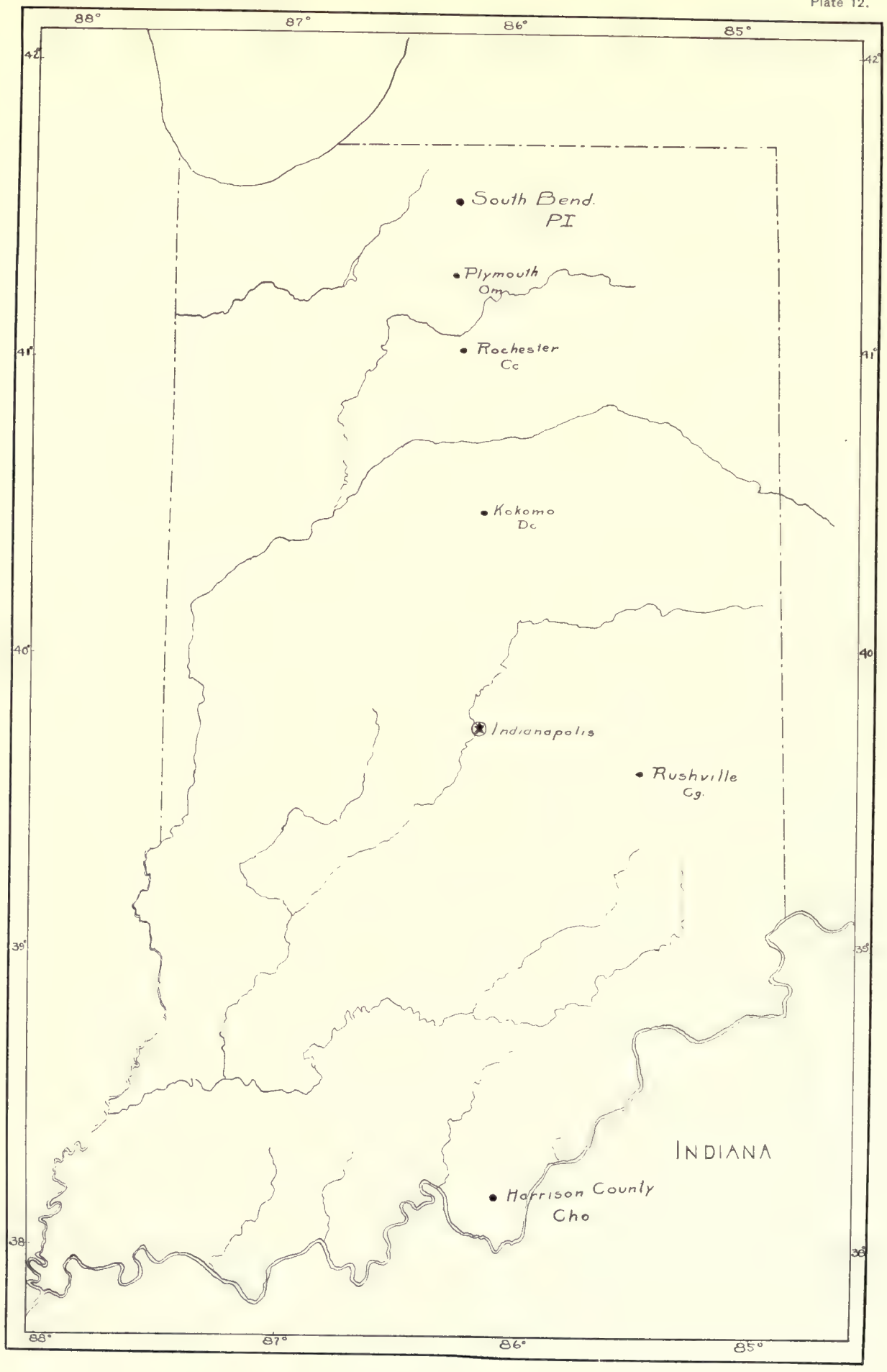
85
84
83
82
81
80
41
40
39
Wooster
Om
New Concord
Cla.
COLUMBUS.
Anderson.
P.
Cincinnati
Ds
Pricetown.
Cw.
Hopewell Mounds.
Om.
OHIO


88°
87°
86°
85°
42°
41°
40°
39°
38°
South Bend.
PI
Plymouth
Om
Rochester
Cc
Kokomo
Dc
Indianapolis
Rushville
Cg.
INDIANA
Harrison County
Cho

90
89
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87
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85
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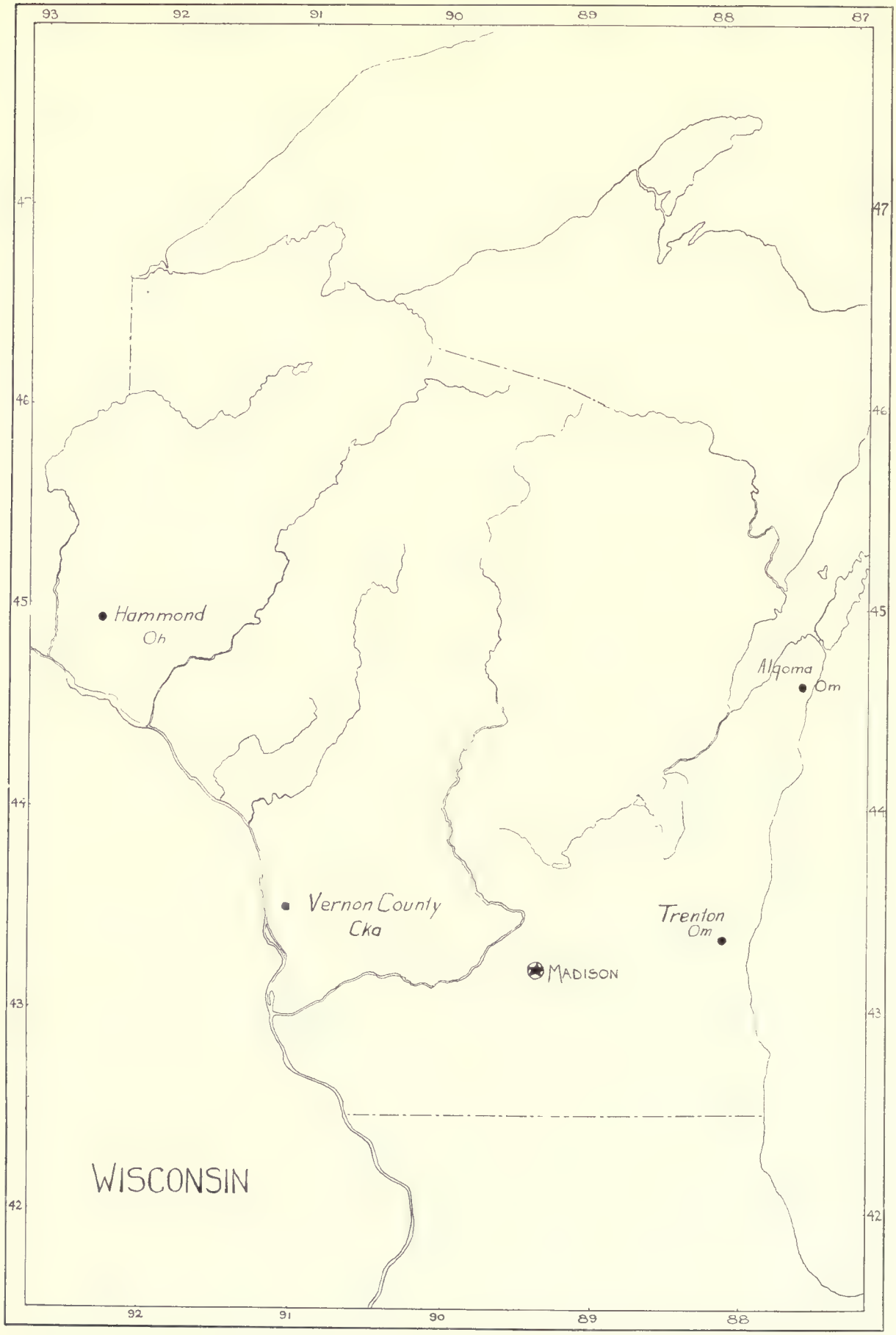
42
41
Reed City.
Om.
Grand Rapids.
Oj
LANSING.
Allegan.
Cso.
MICHIGAN


93
92
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87
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44
43
42
Hammond
Oh
Algoma
Om
Vernon County
Cka
Trenton
Om
MADISON
WISCONSIN

97
96
95
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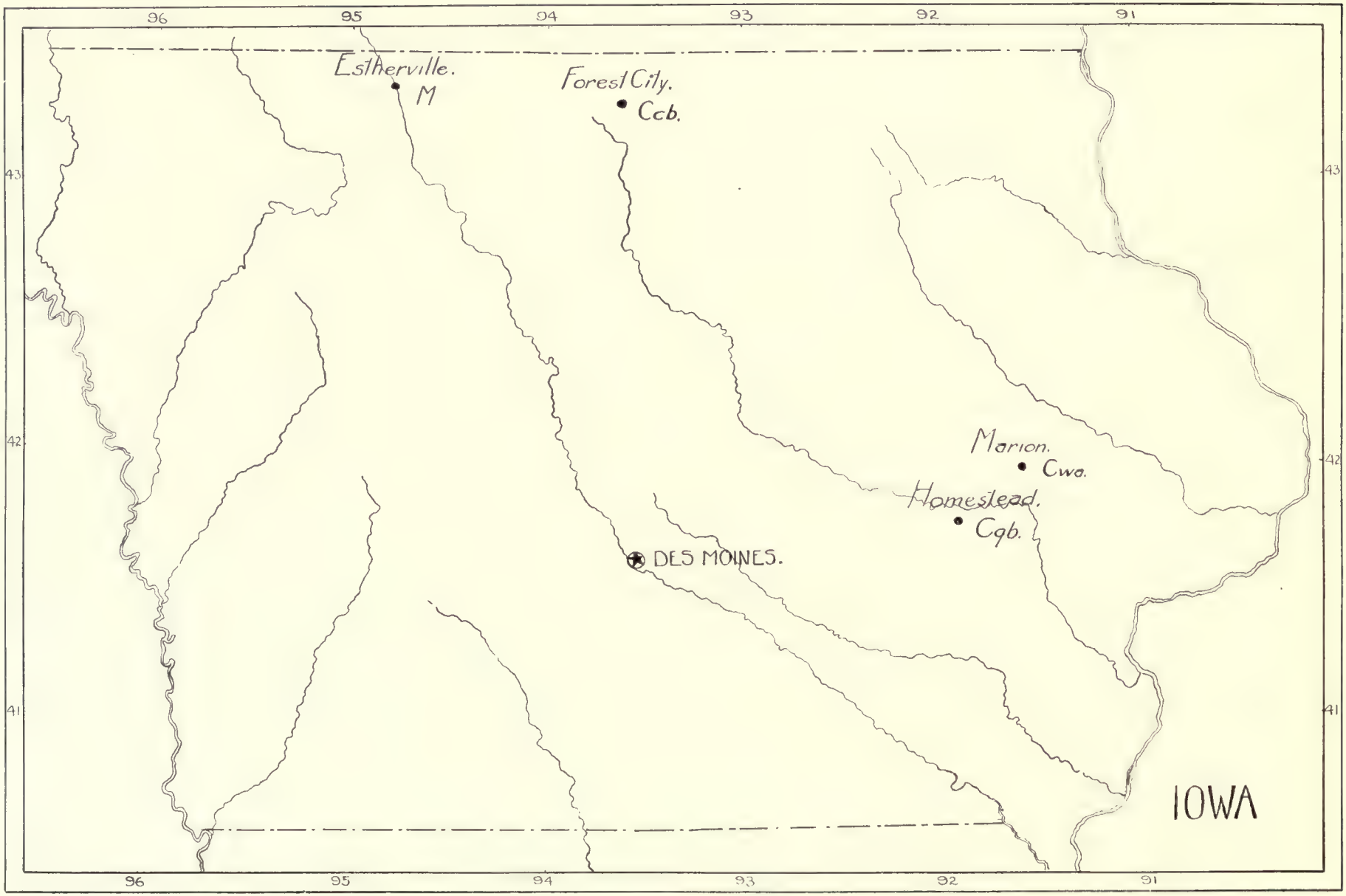
44
43
Fisher.
Cia.
SAINT PAUL.
MINNESOTA
Arlington.
Om.


96
95
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93
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91
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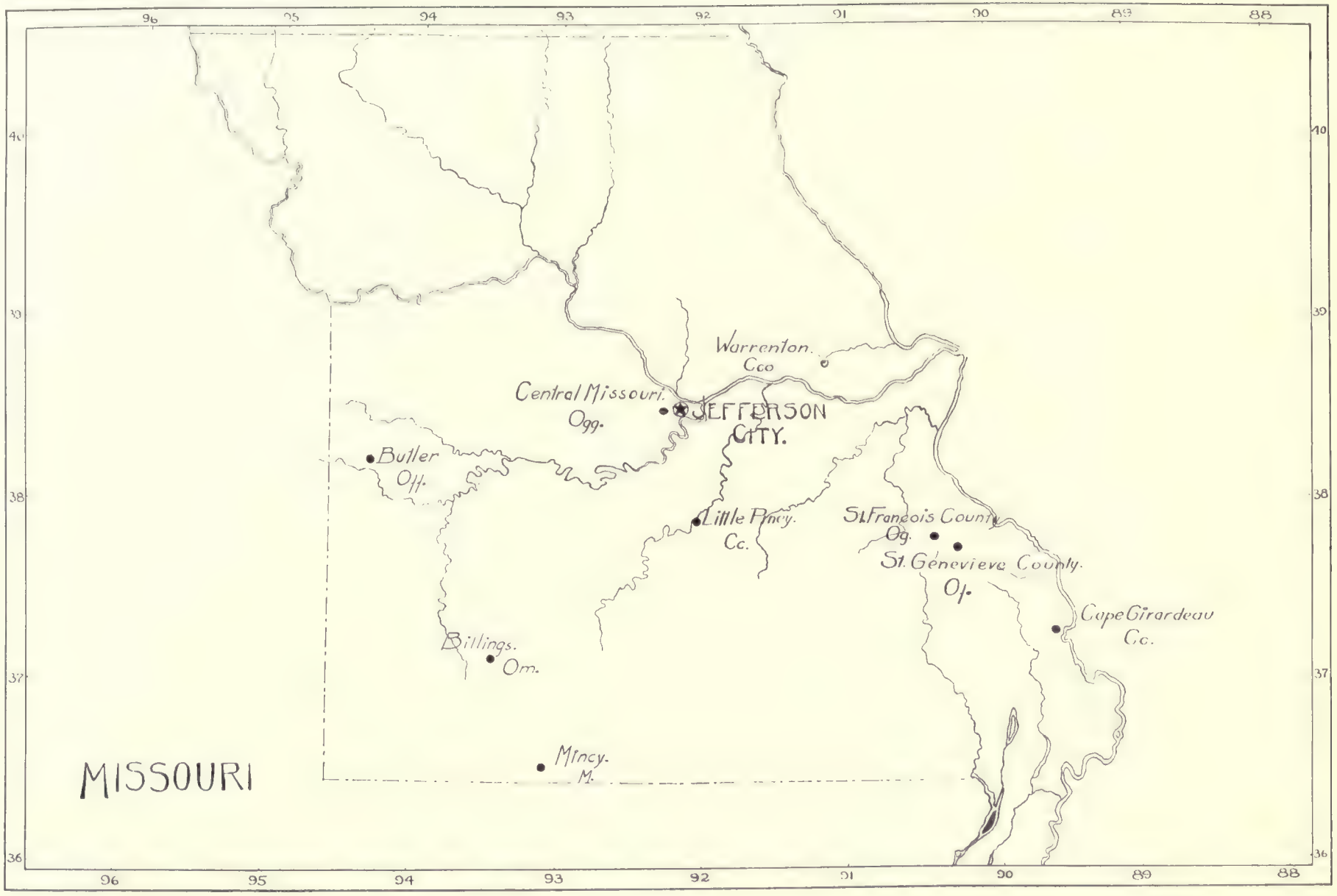
Estherville.
M
Forest City.
Ccb.
Marion.
Cwo.
Homestead.
Cqb.
DES MOINES.
IOWA


96
95
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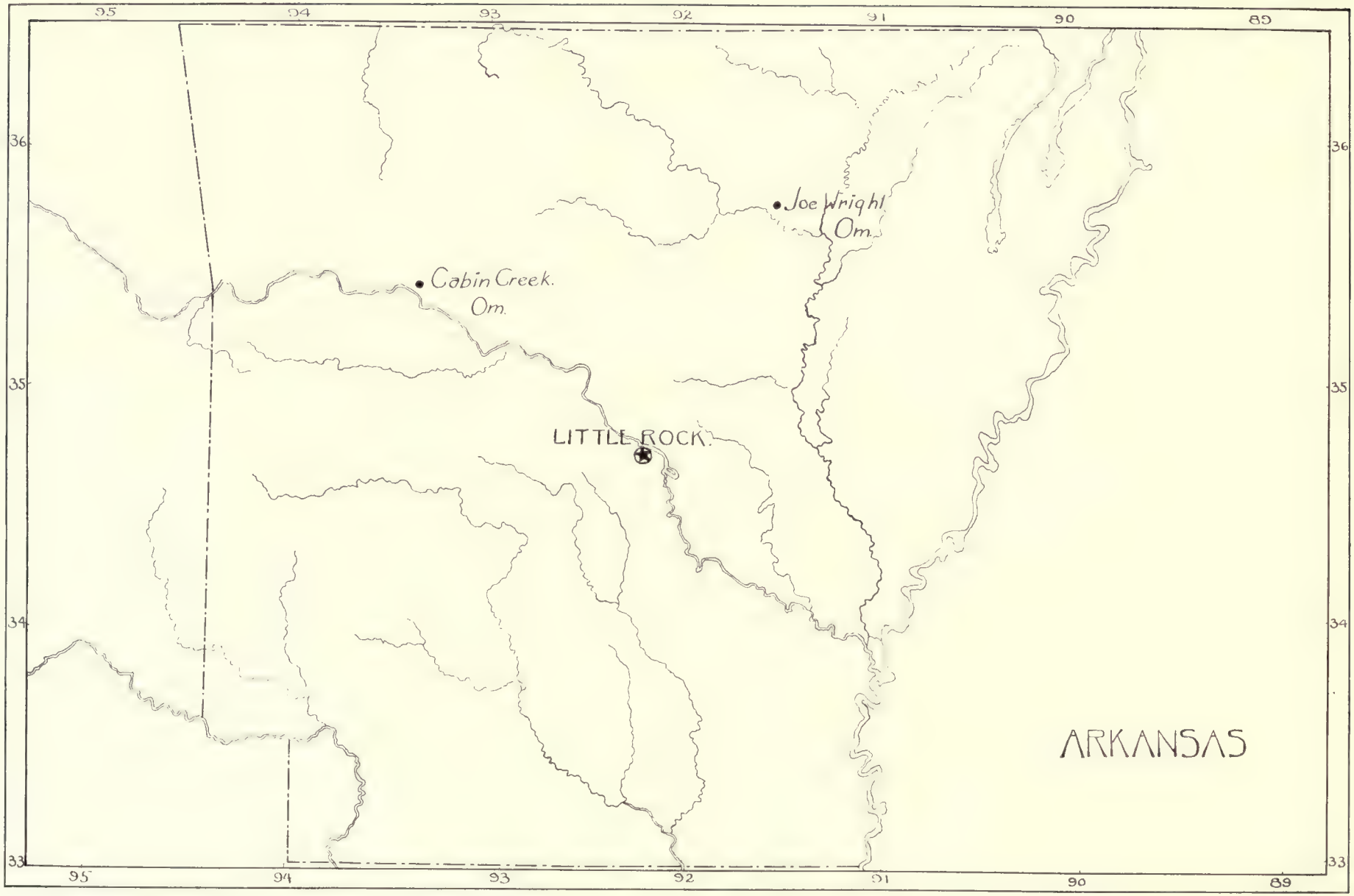
36
Warrenton.
Cco
Central Missouri.
Ogg.
JEFFERSON
CITY.
Butler
Off.
Little Prncy.
Cc.
St. Francois County
Og.
St. Genevieve County.
Of.
Cape Girardeau
Cc.
Billings.
Om.
Mncy.
M.
MISSOURI


95
94
93
92
91
90
89
36
35
34
33
Joe Wright Om.
Cabin Creek. Om.
LITTLE ROCK.
ARKANSAS

N. DAKOTA
Niagara.
Og.
Jamestown
Og.
BISMARCK.
104
103
102
101
100
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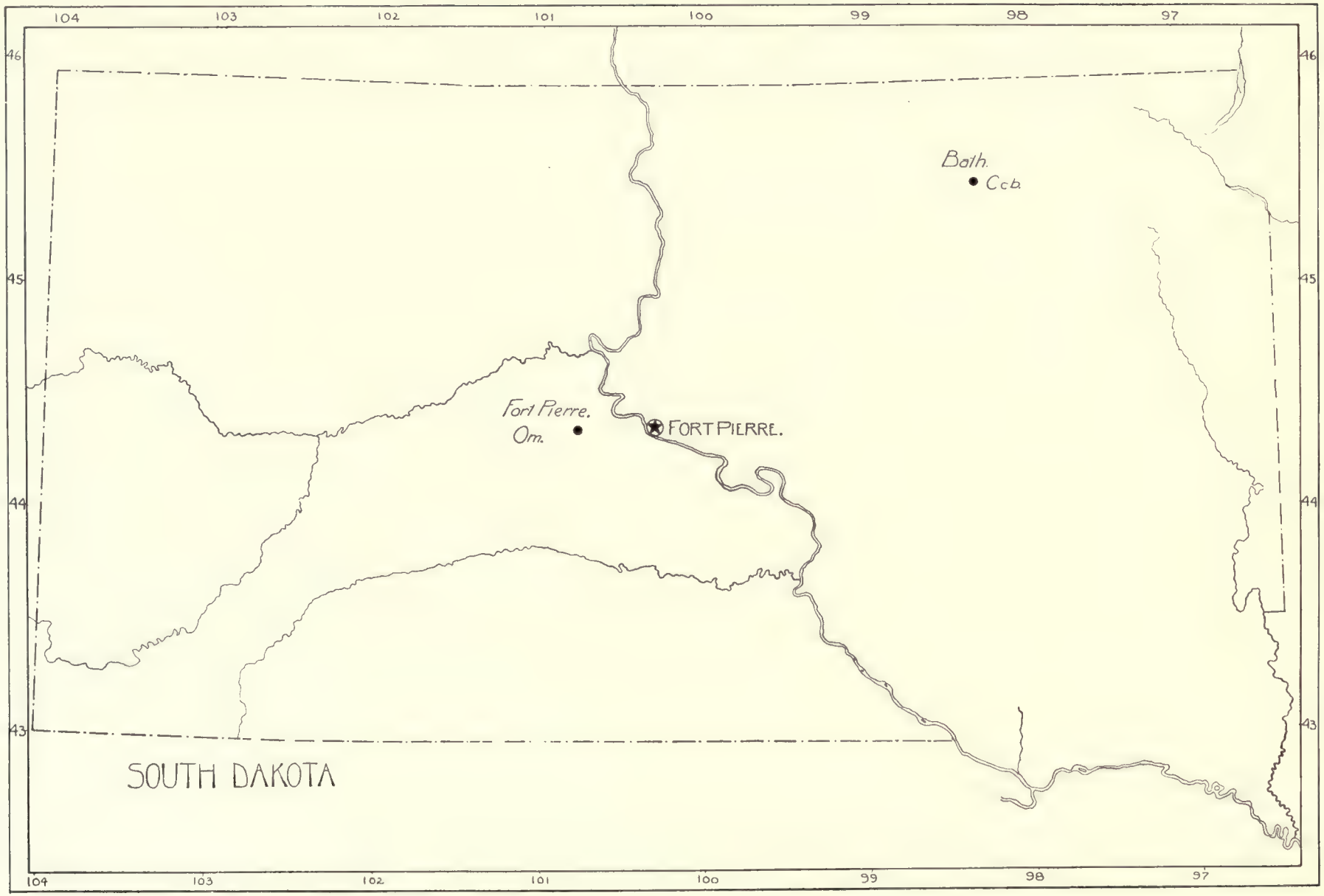
46


104
103
102
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100
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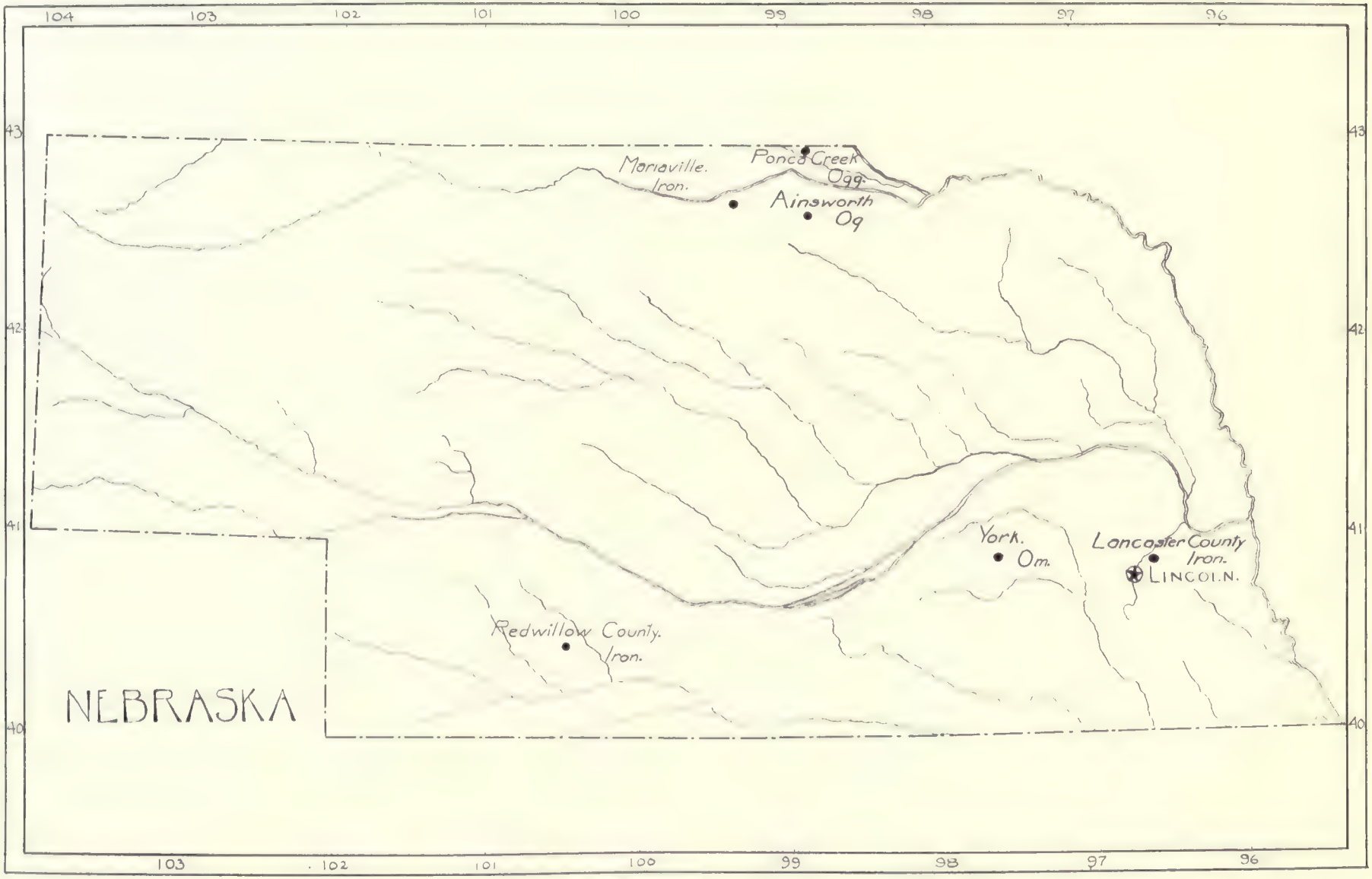
43
Bath.
Ccb.
Fort Pierre.
Om.
FORT PIERRE.
SOUTH DAKOTA


104
103
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101
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96
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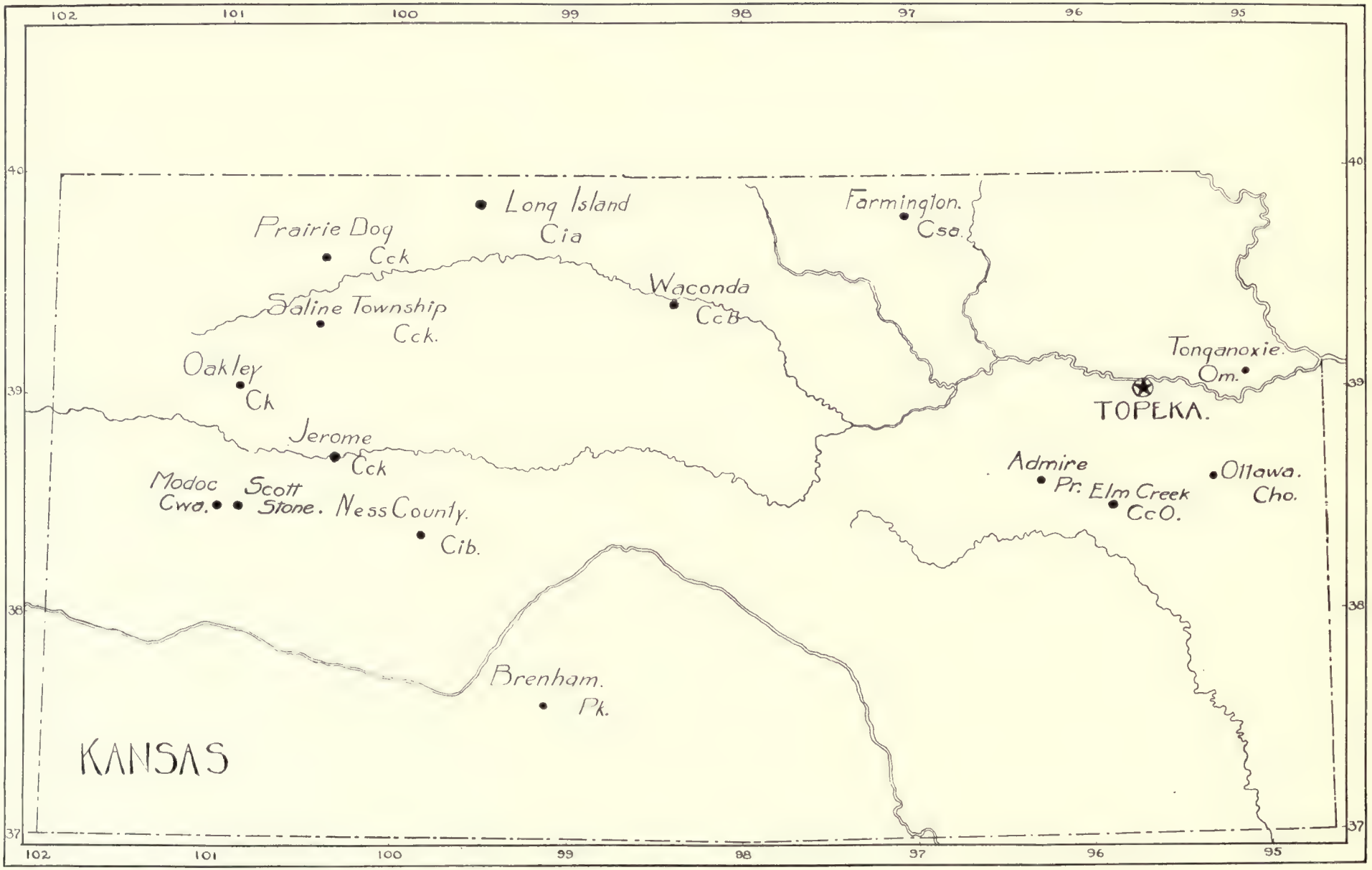
Marlaville.
Iron.
Ponca Creek
Ogg.
Ainsworth
Og
York.
Om.
Lancaster County
Iron.
LINCOLN.
Redwillow County.
Iron.
NEBRASKA


102
101
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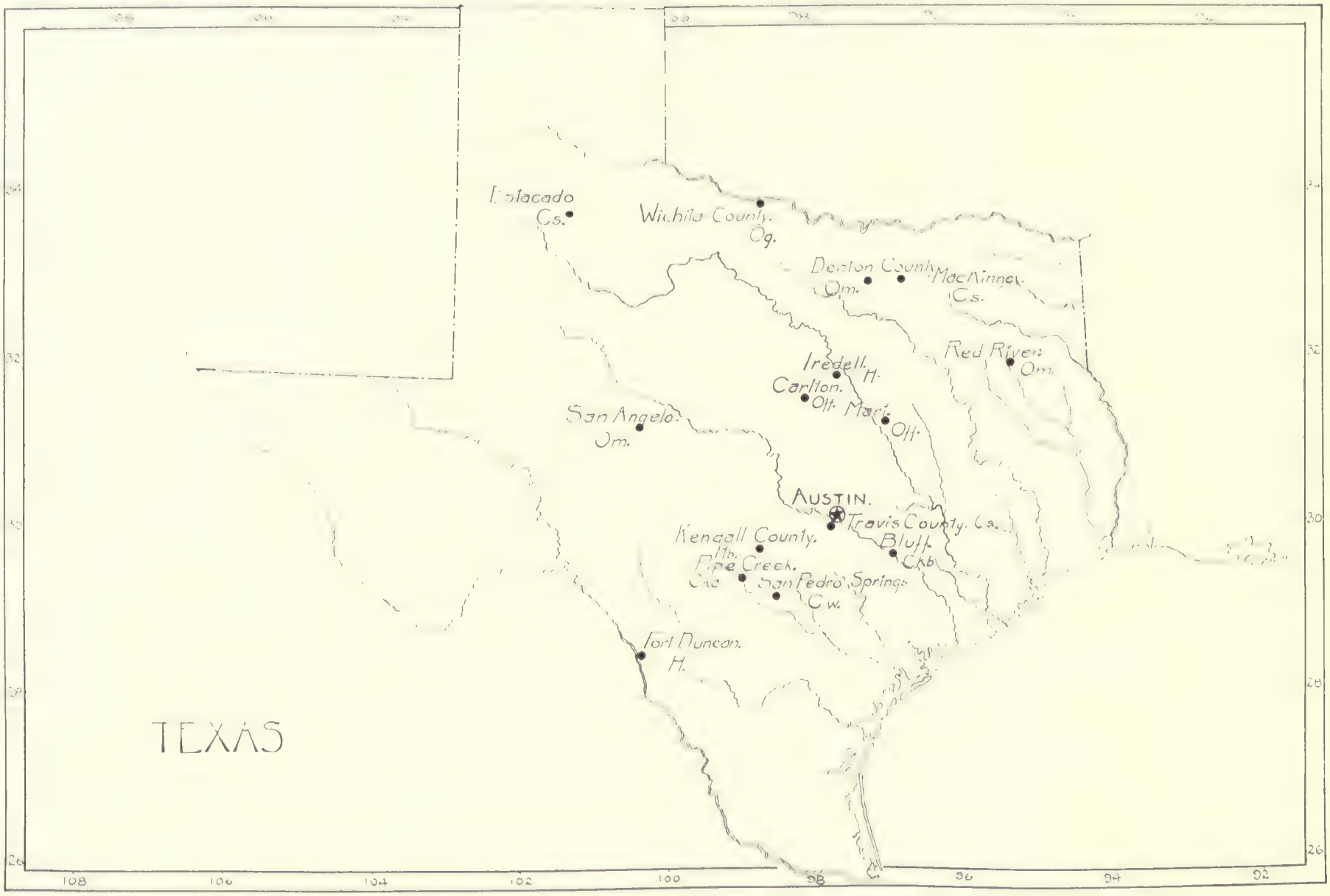
Long Island
Cia
Prairie Dog
Cck
Farmington.
Csa.
Waconda
Ccb
Saline Township
Cck.
Tonganoxie.
Om.
Oakley
Ck
TOPEKA.
Jerome
Cck
Admire
Pr. Elm Creek
CcO.
Ottawa.
Cho.
Modoc
Cwa.
Scott
Stone.
Ness County.
Cib.
Brenham.
Pk.
KANSAS


Estacado
Cs.
Wichita County.
Og.
Denton County
Om.
MacKinney
Cs.
Red River
Om.
Iredell
H.
Carlton.
Olt.
Mart
Olt.
San Angelo
Om.
AUSTIN.
Travis County. Cs.
Kendall County.
Uh.
Pipe Creek.
Chs
San Pedro Springs
Cw.
Bluff.
Chb
Fort Duncan.
H.
TEXAS
108
106
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102
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116
115
114
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112
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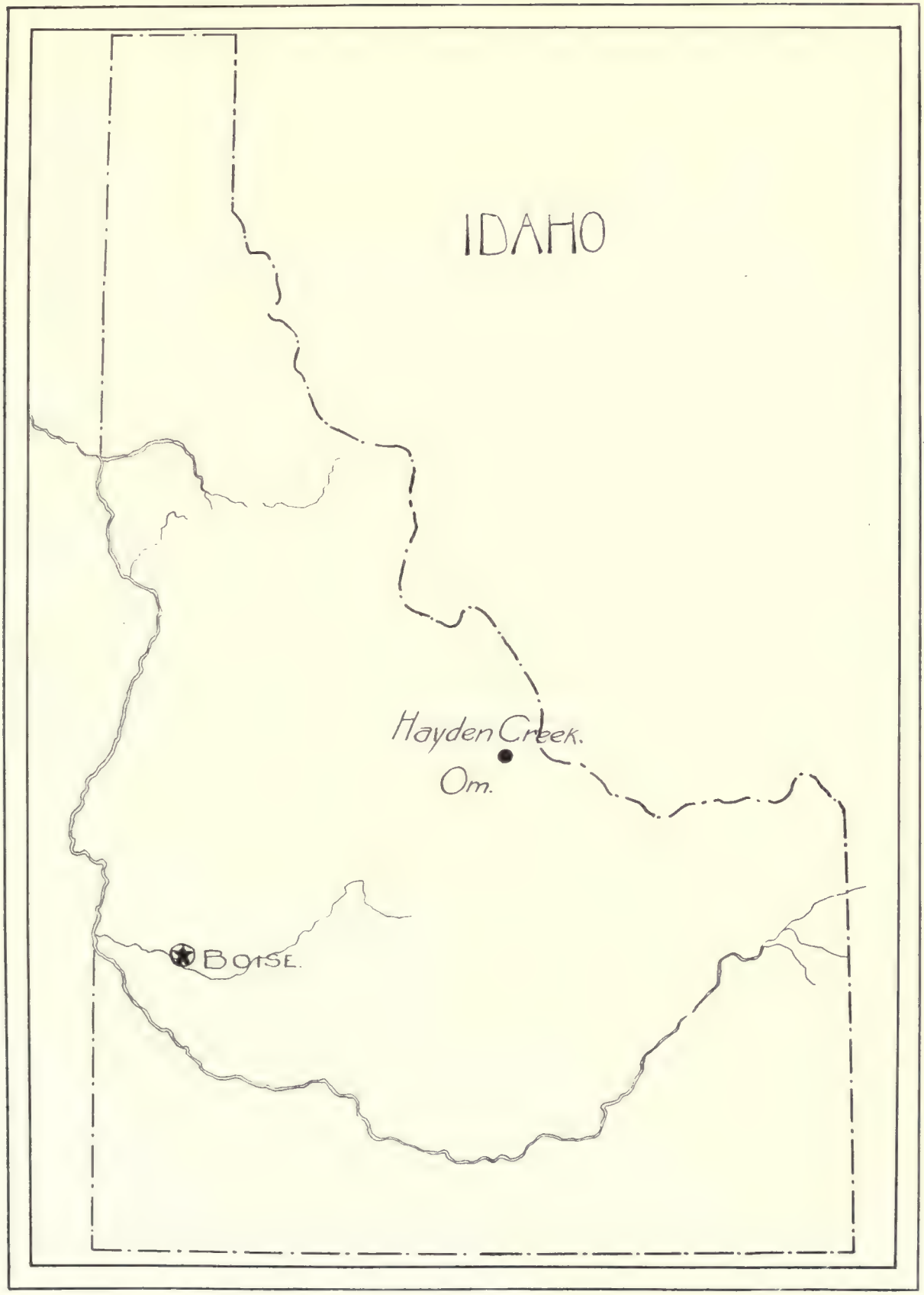
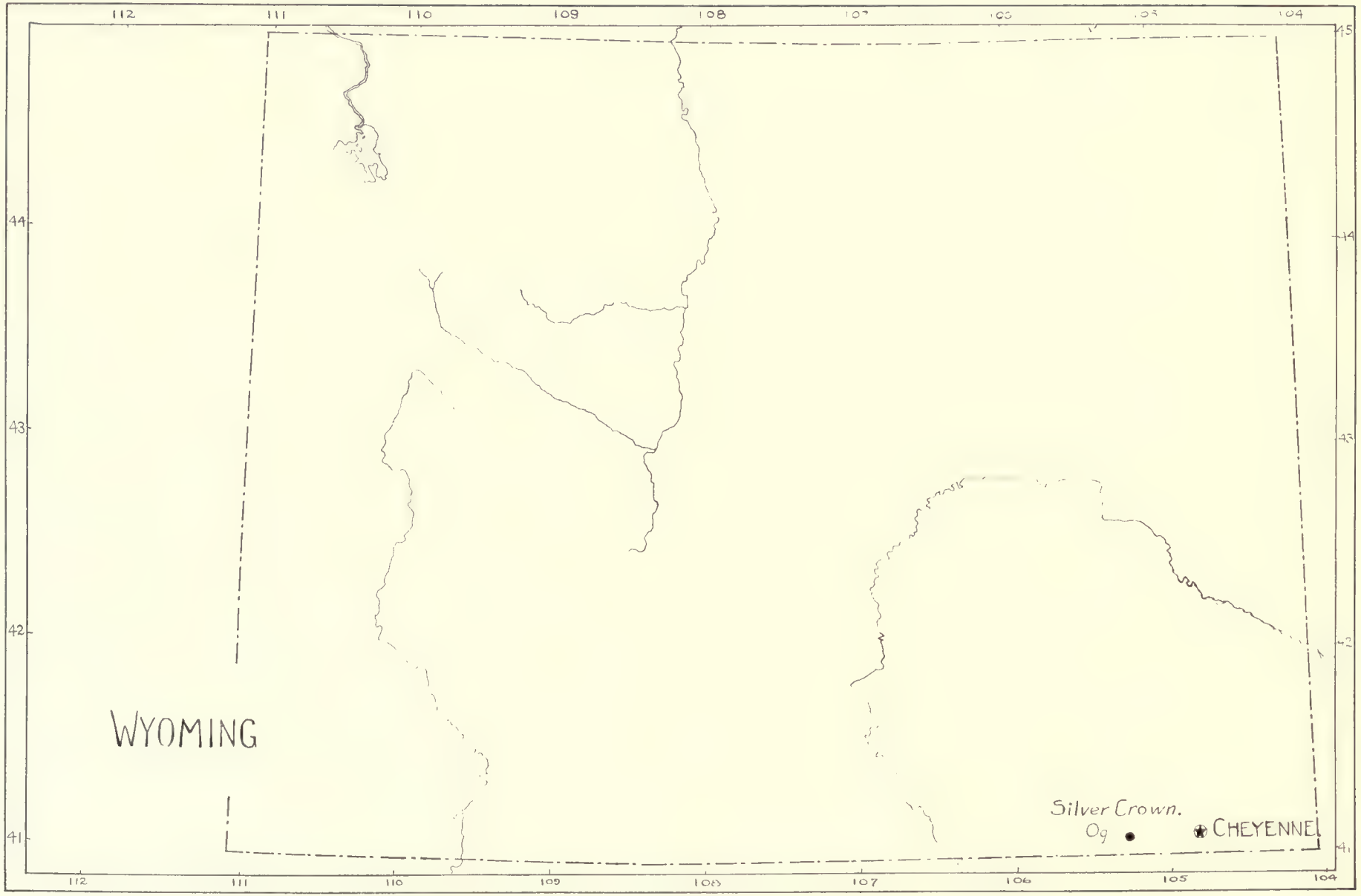
Illinois Gulch.
Dn.
HELENA.
MONTANA


IDAHO
Hayden Creek.
Om.
BOISE.


112
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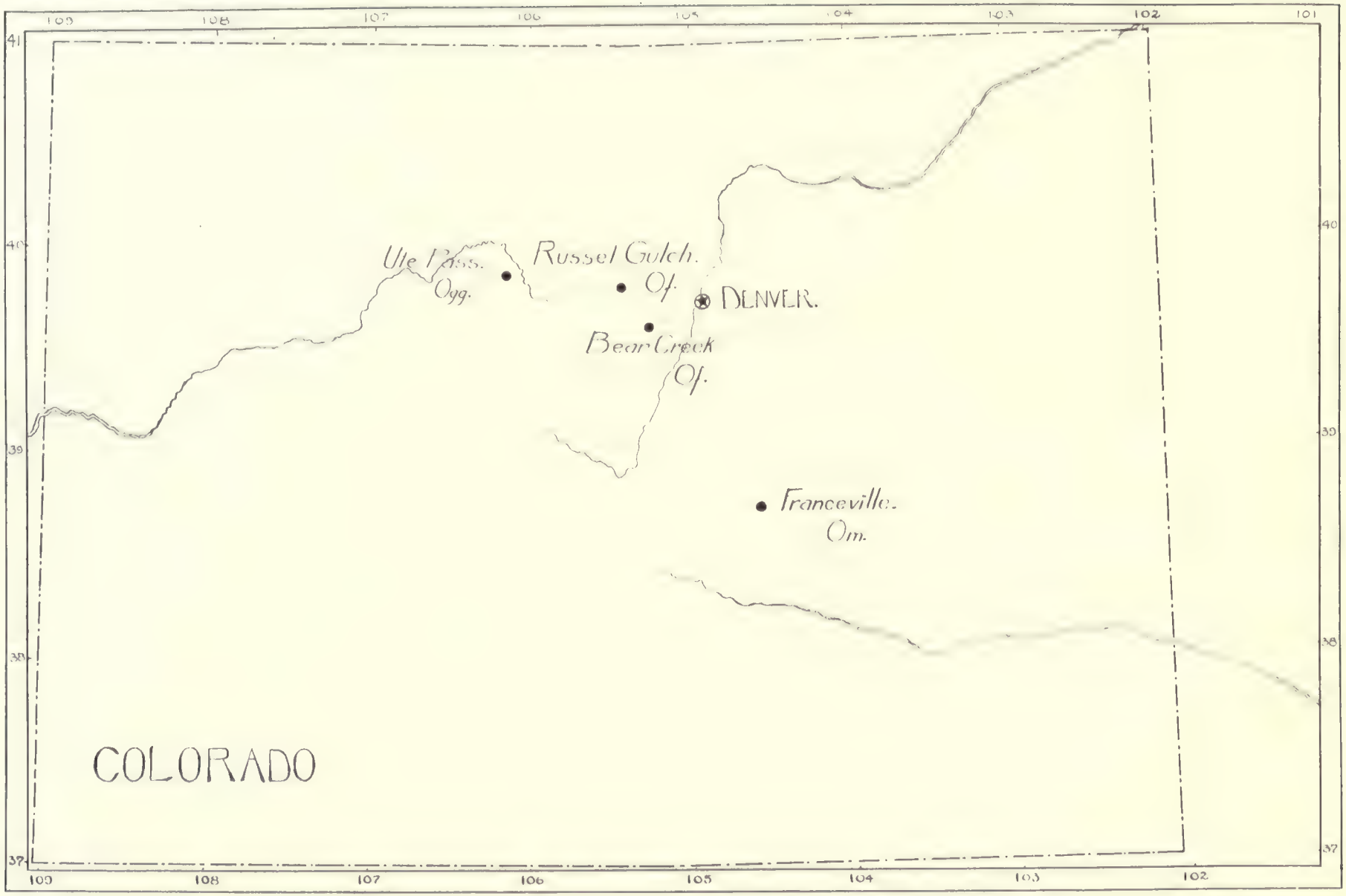
WYOMING
Silver Crown.
Og
CHEYENNE


109
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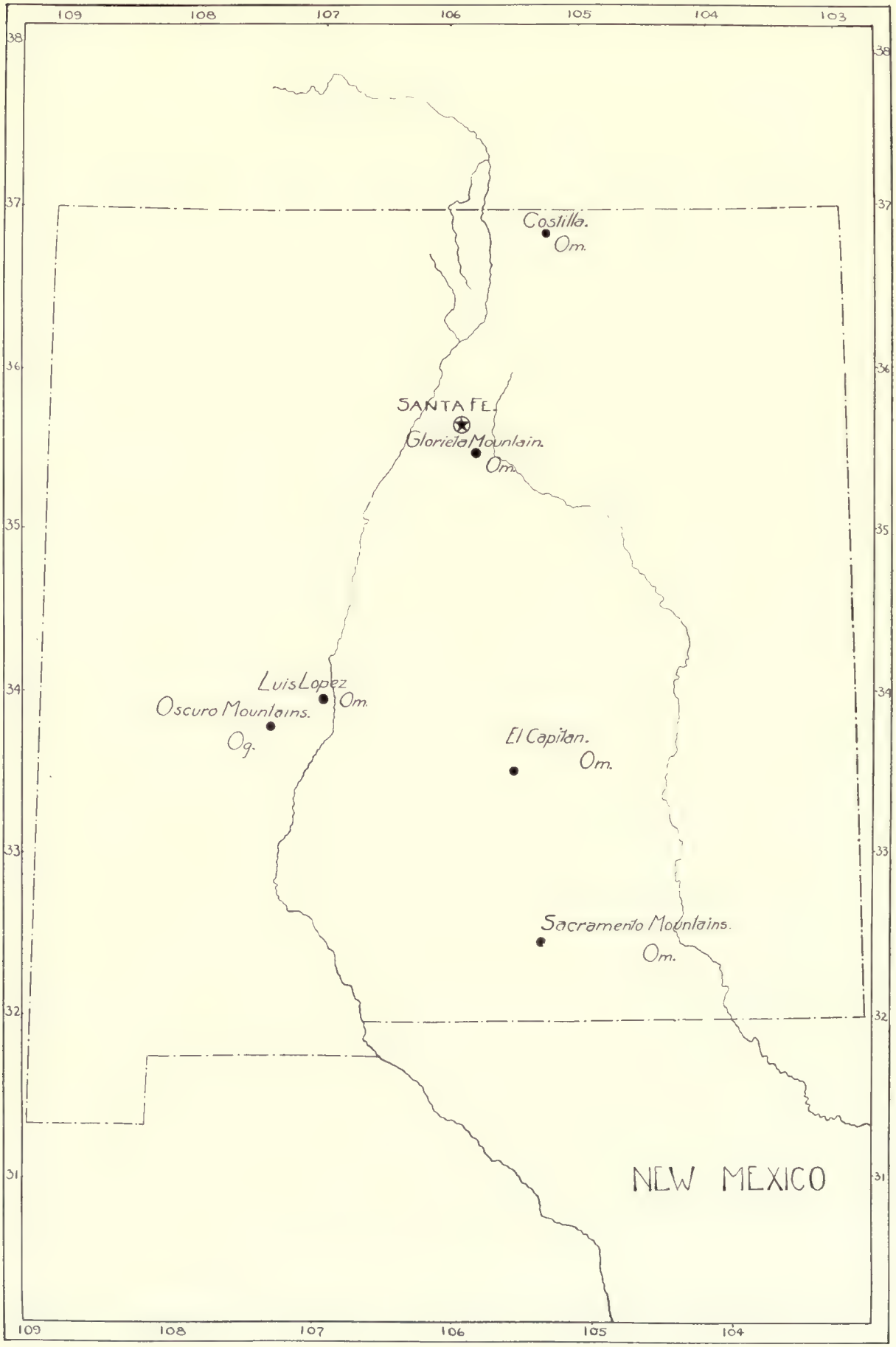
Ute Pass.
Ogg.
Russel Gulch.
Of.
DENVER.
Bear Creek
Of.
Franceville.
Om.
COLORADO


109
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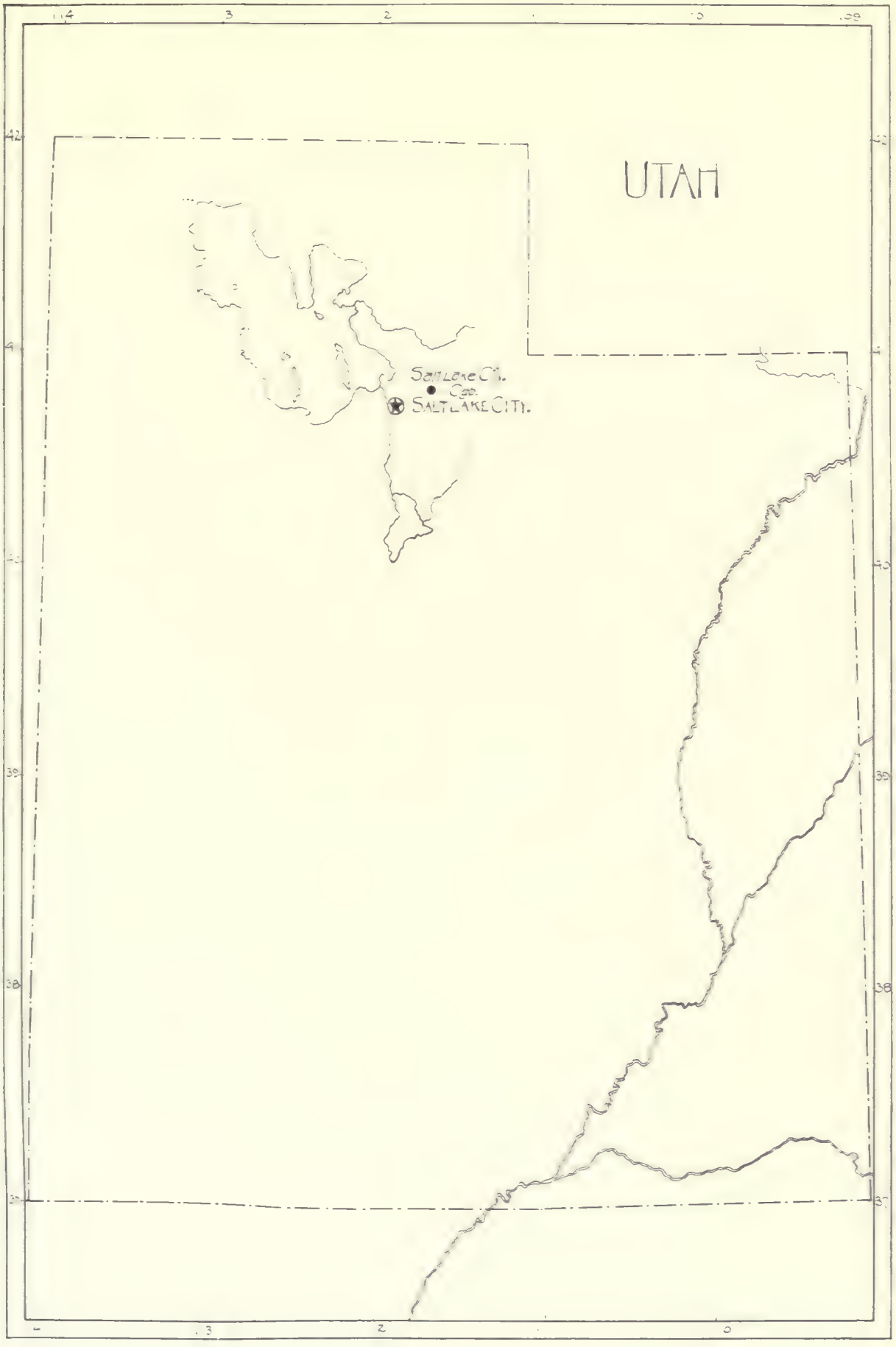
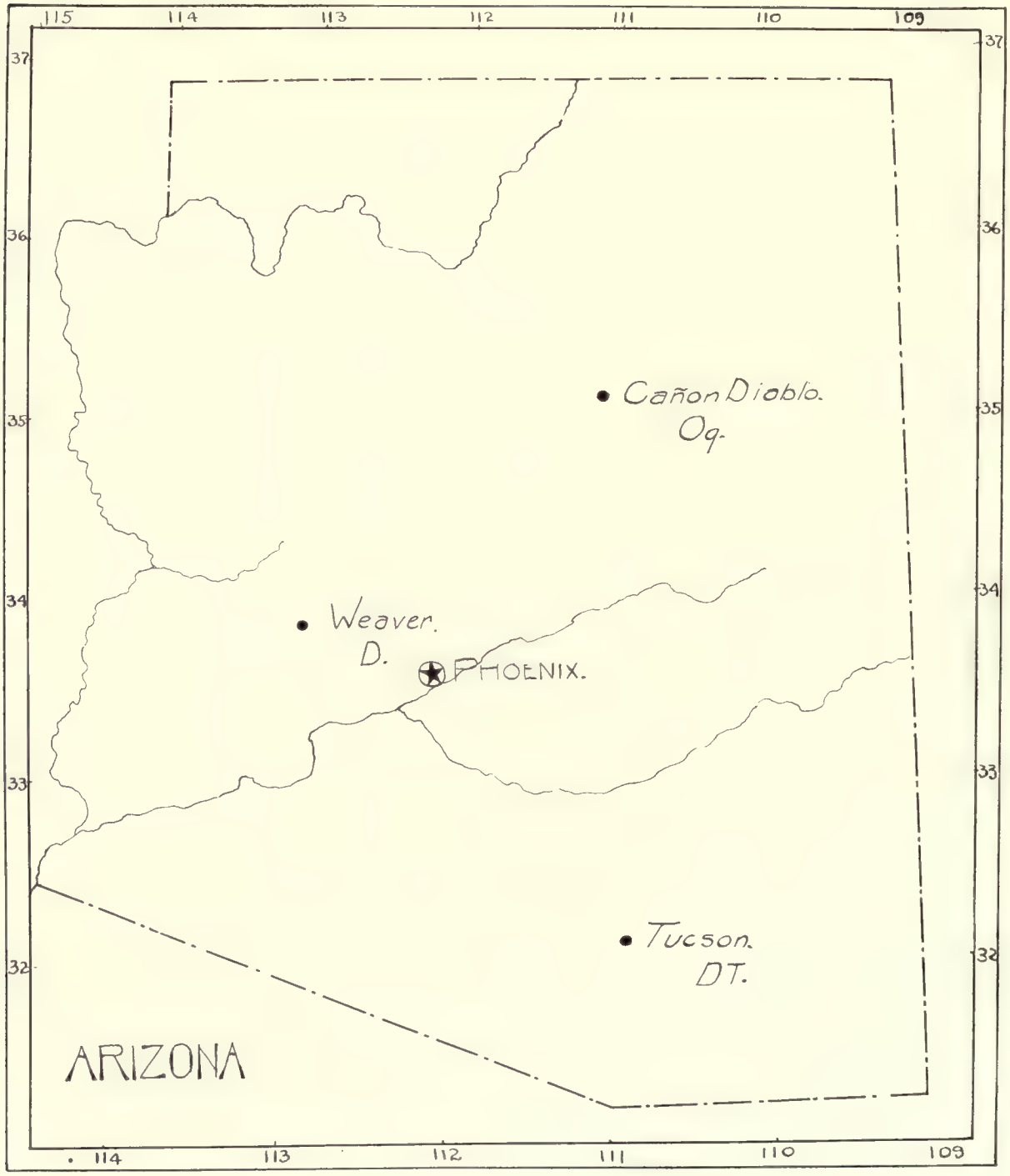
32
31
Costilla.
Om.
SANTA FE.
Glorieta Mountain.
Om.
Luis Lopez
Om.
Oscuro Mountains.
Og.
El Capitan.
Om.
Sacramento Mountains.
Om.
NEW MEXICO


UTAH
Salt Lake Co.
SALT LAKE CITY.


115
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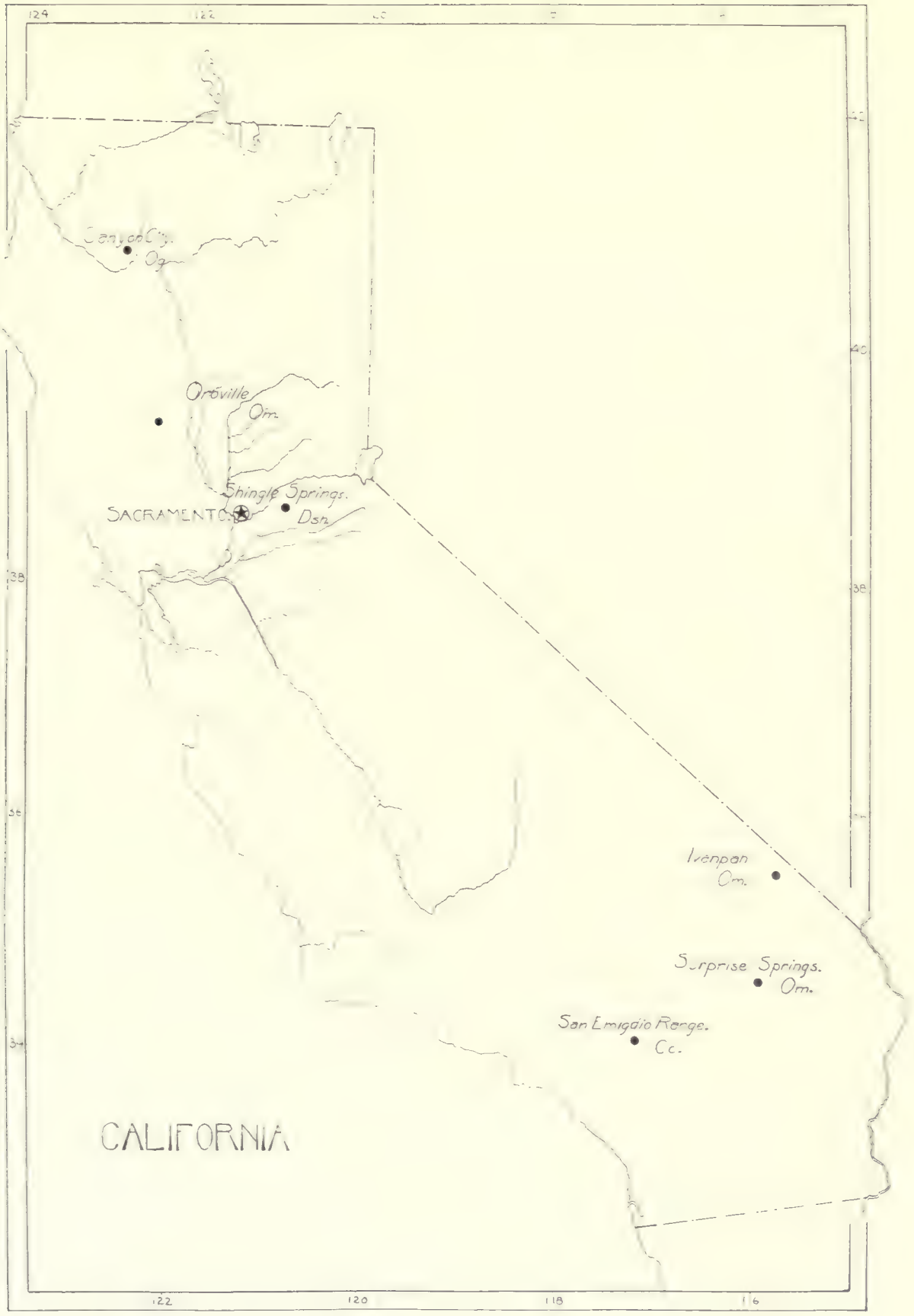
Cañon Diablo.
Oq.
Weaver.
D.
PHOENIX.
Tucson.
DT.
ARIZONA


124
122
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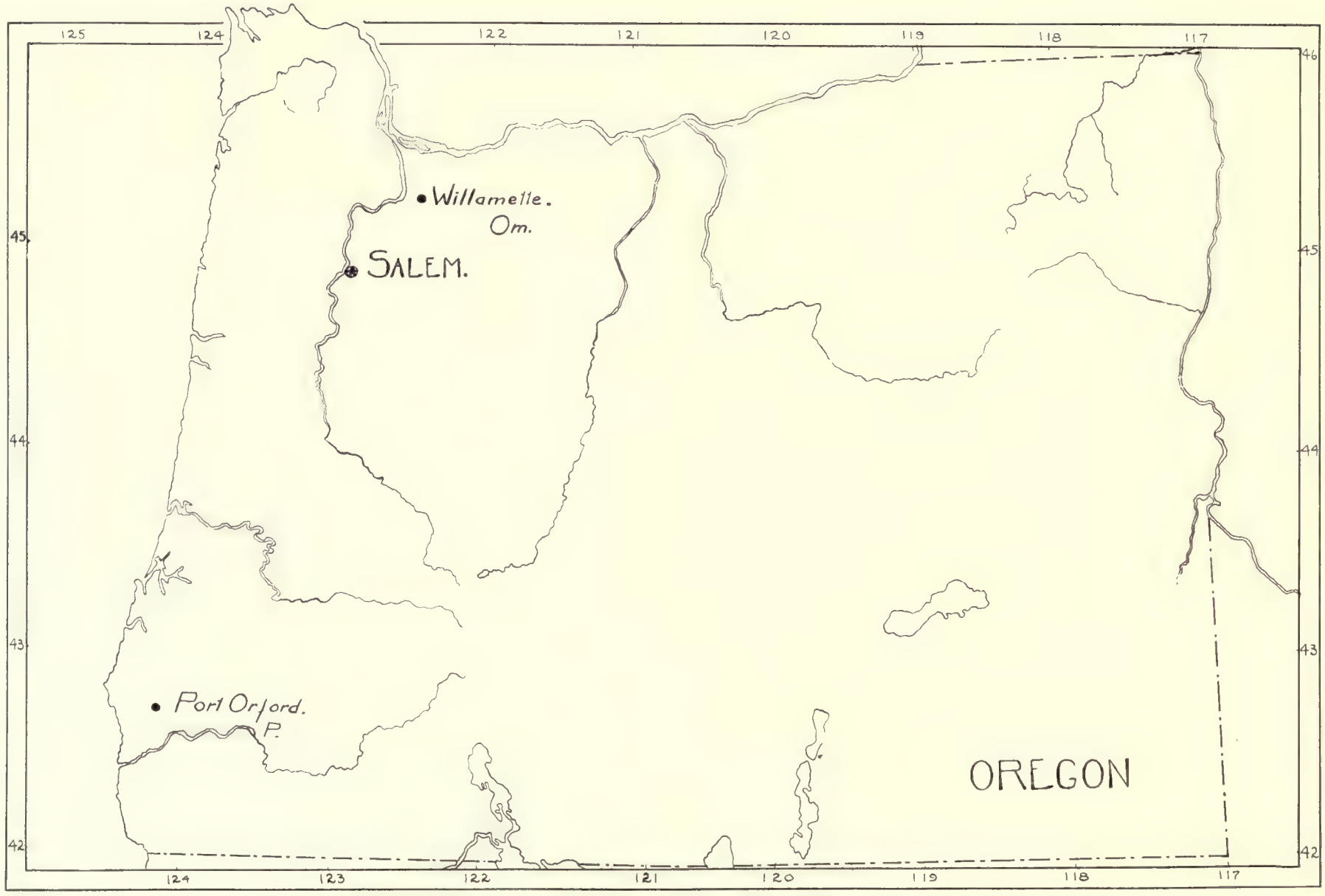
122
120
118
116
Canyon City.
Og.
Oroville
Om.
Shingle Springs.
SACRAMENTO
Dsh.
Ivanpan
Om.
Surprise Springs.
Om.
San Emigdio Range.
Cc.
CALIFORNIA


125
124
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Willamette.
Om.
SALEM.
Port Orford.
P.
OREGON
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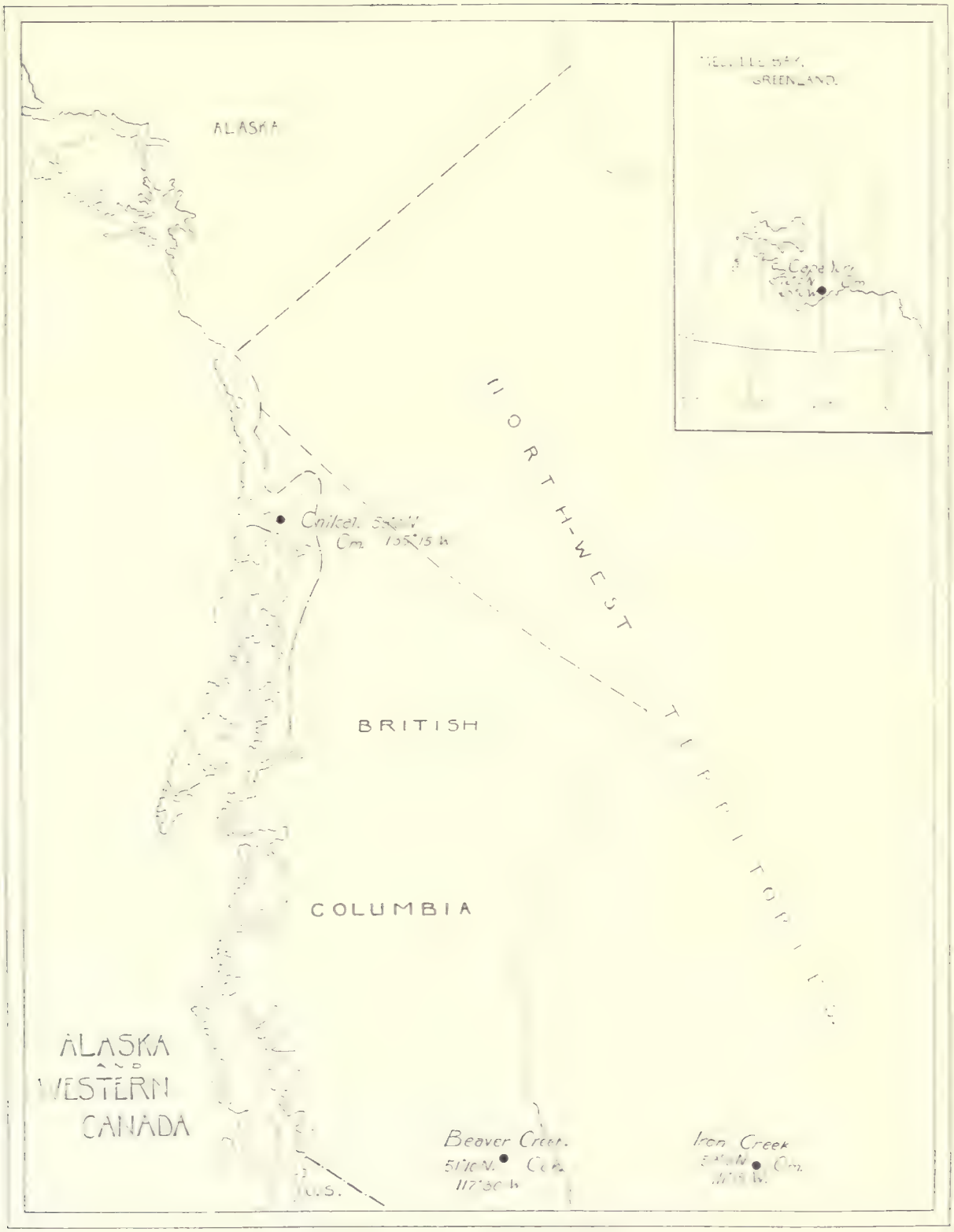
ALASKA
GREENLAND.
NORTH-WEST TERRITORIES
BRITISH
COLUMBIA
ALASKA AND WESTERN CANADA
U.S.
Beaver Creek.
Iron Creek

GEORGIAN
BAY
LAKE HURON
Shelburne.
Cgo.
Madoc.
Of.
Thurlow.
Of.
TORONTO.
LAKE ONTARIO
DeCewsville.
Cw.
Welland.
Om.
LAKE
ST. CLAIR
LAKE ERIE
ONTARIO,
CANADA

MEXICO
CHIHUAHUA
COAHUILA
NUEVO LEON
TAMAULIPAS
DURANGO
ZACATECAS
SAN LUIS POTOSI
AGUASCALIENTES
JALISCO
COLIMA
NAYARIT
SINALOA
SONORA
BAJA CALIFORNIA
GUANAJUATO
QUERETARO
HIDALGO
MEXICO
MICHOACAN
GUERRERO
PUEBLA
OAXACA
TABASCO
CHIAPAS
CAMPECHE
VERACRUZ
Arispe.
Casas Grandes.
Moctezuma.
Chapaderos.
Sierra Blanca
Morita
Adargas
Bachiniva.
Bella Roca.
Sodeo
Avilez
Mazapil
Cocaria
Rancho de la Plata
Descubridora
Mezquital
Chilchinequilas.
Charcas.
Bocas.
Catorce.
Tocatitlan.
Cosina
Pachuca
La Charca
Tamaulan.
Rancho de la Presa.
Toluca.
Amales.
Tlaxcalapa.
Tlaxcalapec.
Apoala.
Yanhuillan.
Misteca.

CUBA
Cuba
Om
Lucky Hill.
Om.
JAMAICA
BRITISH HONDURAS
GUATEMALA
Rosario.
Og.
HONDURAS
SALVADOR
NICARAGUA
COSTA RICA
Heredia.
Ccb.
CENTRAL AMERICA